CONSUMER ACCEPTABILITY AND SALT PERCEPTION OF FOODS WITH A REDUCED SODIUM CONTENT.

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DECLARATION OF INDEPENDENT WORK

I, MARILOUX MALHERBE, do hereby declare that this research project submitted for the degree MAGISTER TECHNOLOCIAE: FOOD AND NUTRITION, is my own independent work that has not been submitted before to any institution by me or anyone else as part of any qualification.

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SIGNATURE OF STUDENT	DATE

VERKLARING TEN OPSIGTE VAN SELFSTANDIGE WERK

Ek, MARILOUX MALHERBE, verklaar hiermee dat die navorsingsprojek wat vir die graad MAGISTER TECHNOLOGIAE: VOEDSEL EN VOEDING aan die Technicon Vrystaat deur my ingedien word, my selfstandige werk is en nie voorheen deur my of enige ander persoon ter verwerwing van enige kwalifikasie ingedien is nie.

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HANDTEKENING VAN STUDENT	DATUM

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CHAPTER 1

THE NUTRITION TRANSITION

1.1. INTRODUCTION

The human being has been able to progressively adapt to changes in the intake of a wide range of naturally occurring foods, brought about during the agricultural revolution, because nutrient combinations (carbohydrates, fats and proteins) generally remained relatively constant. With the industrial revolution, however, radical changes have occurred, especially in developing countries (WHO, 1990:10). These include changes in life-styles and health patterns, characterized by an increase in the prevalence of chronic diseases, changes of principal causes of death as well as changes in dietary intake (Romieu, 1997). These changes are characteristics typical to the "Nutrition Transition", defined by Voster et al., (1995) as "the change in dietary patterns and nutrient intake associated with urbanization, acculturation or westernization."

Changes in dietary intake are due to several factors, not only related to consumer changes, but also to the technology of the industry (Sasson, 1990:96) including food processing, distribution and production methods.

Increases in the number of people moving from rural to urban communities, accompanied by radical changes in diet (WHO, 1990:28) and changes in attitude towards foods typical of industrialized countries (Sasson, 1990:96) have resulted in abandoning of traditional food habits. The industrial revolution, together with imitation of food intake patterns of affluent social classes of industrialized countries (Sasson, 1990:97), have led to major changes in the nutritional composition of the diet in developing countries. The immediate health benefit of this increased and assured food supply has been the elimination of starvation and micronutrient deficiency diseases in many communities (Visek, 1994:555).

On the other hand, rapid industrialization and acculturation, especially of the Black populations in many parts of Africa (Bourne et al., 1993), places communities at risk of developing several degenerative diseases (Bourne et al., 1993; Sasson, 1990:97; Visek, 1994:555). The affluent diet is characterized by an excessive intake of energy-dense foods, rich in fat and deficient in unrefined carbohydrate foods, which are the main source of dietary fiber (Voster et al., 1995).

Changes in population diets in developing countries have been reflected in the disease and mortality profiles of migrant populations, moving from countries with a low-risk for developing degenerative diseases to high-risk countries (WHO, 1990:11). In many instances, South Africa is considered a multi-cultural developing country with broad gradients in socio-economic and cultural factors influencing eating patterns (Voster et al., 1995). Large segments of our population are presently in the process of urbanization. In South Africa, a projection for the year 2010 estimates that seventy percent of South Africa's population will be urbanized at that time, affecting mainly the Black population (Bourne et al., 1993).

1.2. FACTORS THAT CONTRIBUTE TO TRANSITION

Popkin (1994) notes that with the aging of populations, countries move through demographic, epidemiological and nutrition transitions. A need thus exists to understand the link between nutrition and chronic disease patterns.

1.2.1 THE HEALTH TRANSITION

Among the health transition paradigms relevant to urbanization are issues of migration, changes in family structure, food contamination, changes in food habits and lifestyle and an increased consumption of street foods (Solomons and Gross, 1995:90; Atkinson, 1992:37).

The evolution of the diet accompanied by changes in disease patterns are characterized by indicate three distinct stages of progression:

* Demographic transition: This period is characterized by declining of mortality from communicable diseases and malnutrition, housing- and general socio-

economic development and a resultant decrease in fertility and mortality patterns (Kavishe, 1994:208; Popkin, 1994). Decreases in mortality are responsible for the progressive aging of populations, which presents a new set of health and nutritional problems (Young et al., 1994:212).

* Epidemiological transition: Progressive urbanization and industrialization (epidemiological transition) have also been linked to changes in mortality and morbidity. The epidemiological transition is characterized by declines in infectious diseases (Bourne et al., 1993; Voster et al., 1995) and nutrient deficiency diseases (Drewnowski and Popkin, 1997) and increases in the prevalence of chronic diseases (Bourne et al., 1993; Voster et al., 1995) similar to that found in Western populations (Popkin, 1994).

* Environmental transition: This transition started to emerge as a result of the control of chronic non-communicable diseases and has now progressed to a state of environmental and social pathology resulting from environmental exposure and the stressful social conditions in the family, community and workplace (Kavishe, 1994:208).

The demographic and epidemiological transition are linked to a nutrition transition (Kavishe 1994:208; Popkin, 1994).

1.2.2 THE NUTRITION TRANSITION

It is well known that changes in dietary patterns are linked to the process of urbanization and usually associated with the shift from a traditional lifestyle and eating pattern to a partially westernized lifestyle and diet (Bourne et al., 1993). Not surprisingly, therefore, analysis of the dietary patterns of urban and rural dwellers shows striking differences, which, together with changes in lifestyle, value systems and occupational patterns (Young et al., 1994:212), increase the disease burden attributable to these dietary changes (Kavishe, 1994:208).

The nutritional status of subjects in developing countries are characterized by extreme variations between under and overnutrition. Economic and social development have contributed to dietary imbalances prevalent at both extremes (Young et al., 1994:212).

The term Nutrition Transition describes the different stages societies enter as incomes rise and populations become more urbanized (Drewnowski and Popkin, 1997) together with the changes in dietary patterns and nutrient intake associated with urbanization, acculturation or westernization (Voster et al., 1995:119).

The remarkable improvement in the nutritional and health status of many countries during the twentieth century (Young et al., 1994:212; Binns et al., 1994:1999) as a result of the demographic transition and the overall improvement in health has lead to a reduced prevalence of infectious diseases.

While the major problems of malnutrition, seen during the demographic transition, are related to undernutrition of both macro and micronutrients, overconsumption and conditions of excess are major nutritional problems experienced during the epidemiological transition. These include obesity, diabetes, cardiovascular disease, hypertension and cancer, which are associated with the process of urbanization and dietary change (Kavishe, 1994: 208; Solomons and Gross, 1995:90).

Many countries in nutrition transition will therefore experience health problems related to undernutrition side by side with an emerging epidemic of nutrition-related chronic diseases (Binns et al., 1994:199). Undernutrition and overnutrition are concurrent phenomena which are inter linked, not only within urban populations, but also within an individual.

In developing countries, the rate of malnutrition in children under five years is generally higher in rural areas than in urban areas. However, great variations within populations are masked by average data from urban areas (Gross, 1994:363; Atkinson, 1992:6). In contrast to rural populations, obesity is an increasingly widespread problem in urban populations, not only in middle and high-income communities, but also in low-income communities and households (Gross, 1994:363).

1.3. FACTORS INFLUENCING THE NUTRITION SITUATION

Both food and health related factors are involved in the changing nutrition situation.

1.3.1. FOOD RELATED FACTORS

Information from the 60's and 70's indicates that the average food intake per capita is higher in rural populations (Gross, 1994:363), where food supply comes from own production (Solomons and Gross, 1995:90), than in urban areas, where supplies have to be purchased. The improved health situation of urban inhabitants, however, has resulted in improved nutritional status in urban populations (Gross, 1994:363).

Food intake, choices, availability and supply, seem to be the main food related factors which play a role in the changing nutrition situation.

1.3.1.1. FOOD INTAKE

Rural-urban migration brings about changes in the traditional extended multigenerational family structure, places new demands on women's time, and altered availability and distribution of food within households. All may have implications that affect the food intake of the most vulnerable age groups, namely infants, toddlers preschool children, the elderly and mothers (Solomons and Gross, 1995:92).

The major effects implicated in the nutrition transition have been the ready availability of high-fat foods for at-home and away-from-home consumption in urban areas. Popkin and Doak (1998) indicate that the shift from a traditional to a western diet seems to occur worldwide in lower-income countries and includes a large increase in vegetable oil consumption, a shift away from the intake of coarser grains to more refined foods and a shift towards a more diverse diet that includes more meats and eggs.

Although some studies have shown that dietary diversity is a positive diet shift (Beilin, 1994a), Drewnowski and Popkin (1997) explain that a varied diet may be a critical component of the nutrition transition and one of the reasons for the abandoning of the traditional diet.

Long-term exposure to nutrients or other constituents of food seen in the affluent diet which is high in total fat, cholesterol, sugar and refined carbohydrates and low in polyunsaturated fatty acids and fiber (Popkin, 1994), is an important risk factor for the development of degenerative and chronic diseases (Freudenheim, 1991).

From the point of food intake, the historical sequence of the nutrition transition can be described in five broad patterns, as summarized by Popkin (1994) in Table 1.1.

Table 1.1 A summary of the historical sequence of the nutrition transition (Adapted from Popkin, 1994)

Social and Economic factors	**Pattern 1: Collecting food**	**Pattern 2: Famine**	**Pattern 3: Receding famine**	**Pattern 4: Degenerative diseases**	**Pattern 5: Behavioral change**
Nutrition: 1. Diet	• Plants, • Wild animals; • Varied diet	• Cereals predominant; • Diet less varied	• ↓ starchy staples; • and ↑ fruits, vegetables and animal protein; • Low variety continues	• ↑ fat (from animal products), • ↑ sugar and processed foods, • ↓ fiber	• ↓ fat and processed food intake • ↑ in carbohydrate, fruits and vegetables intake.
2. Nutritional status	• Robust • Lean • Few nutritional deficiencies.	• Children and women suffer more from low fat intake. • Nutritional deficiency diseases emerge, stature decline.	• Continued maternal/child nutritional problems. • Many deficiencies disappear. • Weaning diseases emerge. • Stature grows.	• Obesity • Problems for elderly and many disabling conditions	• ↓ body fat levels and obesity; • ↑ bone health.
Demography 1.Mortality/ fertility	• Low fertility. • High mortality • Low life expectancy.	• High natural fertility. • Low life expectancy. • High infant and maternal mortality.	• Mortality decline. • Fertility static, then declines. • Cumulative population growth.	• Life expectancy reaches high levels (60s – 70s). • Fertility low and fluctuating.	• Life expectancy extends to 70s, 80s. • Disability – free life expectancy increases

Table 1.1 A summary of the historical sequence of the nutrition transition (Adapted from Popkin, 1994) (Continued).

Social and Economic factors	Pattern 1: Collecting food	Pattern 2: Famine	Pattern 3: Receding famine	Pattern4: Degenerative diseases	Pattern5: Behavioral change
2.Morbidity	• High prevalence of infectious diseases. • No epidemics.	• Epidemics. • Endemic disease (plaque, smallpox, polio, TB) • Deficiency diseases emerge, and starving common.	• TB, smallpox, infection, parasitic disease, polio, • Weaning diseases, diarrhea and retarded growth expand, • And ↓ later.	• Chronic diseases related to diet (↑ heart disease, cancer) • Infectious diseases decline.	• ↑ health promotion (preventive and therapeutic) • ↓ in coronary heart disease. • Improvement in age-specific cancer profile.
3.Residency patterns	• Low density	• Rural. • A few crowded cities.	• Chiefly rural. • Move to cities ↑. • International migration begins; large cities develop.	• Urban population disperses. • ↓ Rural green space	• Lower density cities rejuvenate. • ↑ Urbanization of rural areas around cities
4.Food processing	• Rudimentary	• Food storage begins	• Storage process (drying, salting), canning and processing technologies ↑. • ↑ food refining and milling	• Numerous foods-transforming technologies	• Technologies create foods and food constituent substitutes (e.g., macronutrient substitutes).

i) FAT AND CARBOHYDRATE INTAKE

With the Nutrition transition, traditional diets high in complex carbohydrates and rich in fibers and grains, have changed to a varied diet that includes higher proportions of fats and sugars (Drewnowski and Popkin, 1997). As a result, diet variety and the proportion of fats in the diet are sometimes directly linked.

When literature compares communities with a high intake of traditional foods (i.e., having ≥ twenty percent of the total dietary energy from traditional food systems) (Receveur et al., 1997) with those with a low traditional food intake (i.e., < twenty percent of total dietary energy from traditional food systems), the low traditional food intake contributes to approximately 15 percent higher total energy, carbohydrate, total fat and saturated fat intake (Receveur et al., 1997).

Food consumption surveys done in urban African countries like Mozambique, have also shown a large increase in fat consumption (Popkin, 1994). The composition of diets of adults in Cape Town have been shown to change in proportion to time spent living in an urban environment. Subjects living in the urban area for the longest period have the highest consumption of energy from fat and the lowest carbohydrate intake (Bourne et al., 1993).

Figure 1.1. indicates the degree of decrease in carbohydrate intake and increase in the fat and saturated fat intake of black residents (age 15-65) of Cape Town, during increased exposure to the urban environment (Bourne et al., 1993).

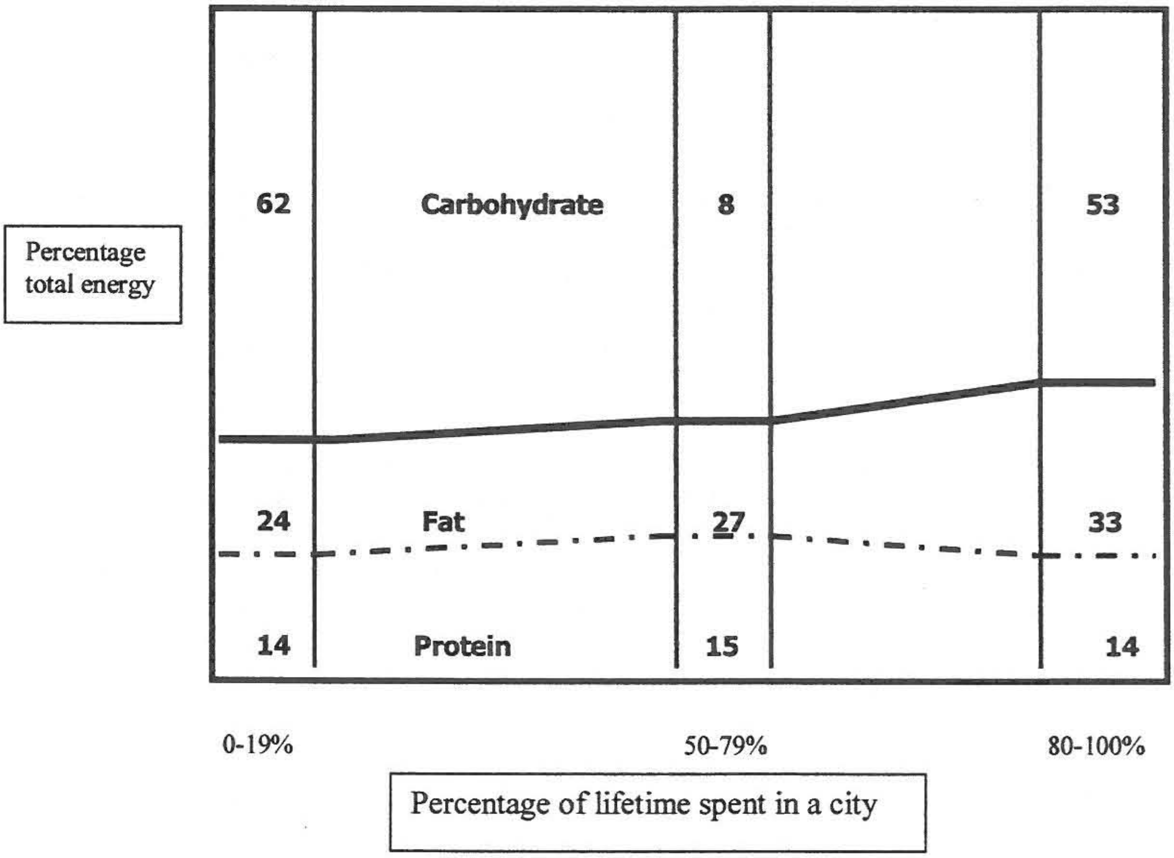

Figure 1.1 Urbanization and changes in diet structure (Adapted from Bourne et al., 1993).

Although the changes in fat intake brought about by westernization has been associated with increased intake of animal fat, Drewnowski and Popkin (1997) state that the availability of cheap fats, oilseed-based fats and the refining of high-quality vegetable oils has also increased. The nutrition transition in many developing countries usually begins with an increased intake of vegetable oils (Popkin and Doak, 1998) rather than an increased intake of meat and milk, which usually occurs later (Drewnowski and Popkin, 1997).

ii) PROTEIN INTAKE

The World Health Organization's INTERHEALTH Program (1954 to 1986) indicates that as fat availability has risen and replaced carbohydrates as an energy source, the proportion of animal protein in the diet tends to increase proportionally (Posner et al, 1994). Popkin (1994) and Bourne et al., (1994) also indicate that the proportion of animal protein increases while that from plant sources decreased proportionally to the time spent living in urban areas.

Historically, the association between high dietary protein intake and elevated blood pressure originates from Kempner's early rice-fruit diet treatment for severe hypertension (Obarzanek et al, 1996). This approach was encouraged by early study observations of consistently lower blood pressure in vegetarians (Beilin, 1994a) compared with populations living in industrialized countries.

Recent evidence, however, of the effect of dietary protein on blood pressure is conflicting (Einhorn and Landsberg, 1988:1276; Beilin, 1994a). Recent study-analyses indicate that dietary protein is inversely related to blood pressure (Obarzanek et al., 1996). Low-protein diets used in some studies contribute to lower blood pressure, while vegetarians in western society have been reported to have blood pressure equal to those of non vegetarians with the same weight (Einhorn and Landsberg, 1988:1276). Not all vegetarian population studies have shown lower blood pressure levels and Beilin (1994b) ascribes this to the effects of psychosocial, dietary and other lifestyle characteristics. Thus, the underlying relationship between the amount or type of protein on blood pressure is yet unknown.

1.3.1.2. FOOD CHOICES, AVAILABILITY AND SUPPLY

As developing countries consume increasingly more western foods (Gross, 1994:363) the intake of more highly processed foods and additives, including sodium salts, simple sugars (Solomons and Gross, 1995:92) and fast foods (Gross, 1994: 363) increases. The "westernization" of global eating habits is often singularly held responsible for the rising rate of associated chronic disease (Drewnowski and Popkin, 1997).

The report of a WHO Study Group (1990:36) emphasizes that the impact of urbanization on the nature of the food supply is immediate. Rapid urbanization has a major influence in accelerating the nutrition transition, because urbanization promotes marked changes in food consumption behaviour with demands for greater variety and convenience (Young, 1994: 213).

While wealthy industrialized nations in North America and the European Union try to convince their populations to change their diet to diets based on grains, vegetables and fruit, populations in developing countries use their growing income to abandon their traditional diets (Drewnowski and Popkin, 1997). The traditional diets of rural Blacks in South Africa, low in fat and high in unrefined carbohydrate and dietary fiber (Voster et al., 1995), are now changing to a more varied diet with increased consumption of foods containing fat, animal protein, salt, sugar (Kavishe, 1994:208; Bourne et al., 1993; WHO, 1990:37) and refined cereals (Younge et al., 1994:213). Changes in lifestyles, value systems and occupational patterns (Young et al., 1994:212) further increase the disease burden (Kavishe, 1994:208).

Urbanization also leads to the dispersion of the family at mealtimes, and promotes the use of fast foods and street foods bought from the mobile carts of street vendors (Solomons and Gross, 1995:93). Freudenheim (1991) indicates that, at least in the United States, it appears that there is increasingly less regularity in eating habits with more people eating in restaurants and more frequently including a variety of ethnic foods.

Within the urban setting, the food industry can exert substantial influence by promoting the consumption of meat products, confectionery, snack foods and other convenience foods (WHO, 1990:37). Sowers and Stumbo (1986) emphasize the variation and significant increase in sodium consumption that has developed as a result of changes in food processing and food consumption patterns. Other studies also indicate that even low-income societies and population groups in third world countries undergoing the nutrition transition (Popkin, 1994) now have access to a high-fat diet (Drewnowski and Popkin, 1997). This change in eating habits in third world countries is reflected in the increasing proportion of people consuming the type of diet associated with a number of chronic diseases (Popkin, 1994) such as hypertension and heart disease, which are already major health problems in many African cities (WHO, 1990:37).

1.3.2. DISEASES OF LIFESTYLE

Undernutrition is closely associated with infectious and invasive diseases (Gross, 1994:364). Overnutrition is linked to economic and environmental development as well as changes in lifestyle and dietary patterns (WHO, 1990:33), contributing to several forms of non-communicable diseases. In developing countries the burden of chronic diseases now nearly equals that of infectious diseases (Beyers et al., 1994:202).

The WHO Study Group (1990:34) as well as studies done by Scrimshaw (1994:122) have concluded that the epidemiological data of developing and developed countries, indicate that there is usually an increase in the emergence of chronic diseases as they adapt to the dietary patterns of industrialized countries and become more westernized.

Since the abolition in 1986 of laws preventing migration to the cities by Blacks, the urban Black population has increased dramatically, thus exposing ever increasing numbers of Blacks to the pressures of urban life (Atkinson, 1992:32; Bourne et al., 1993). This has highlighted the need to determine the contribution of the diet to the development of illness, such as hypertension, for preventive or remedial actions in this population-group (Bourne et al., 1993).

Changes in nutrition-related diseases occur more commonly between different cultural stages in population groups undergoing the transition. For example, the Australian Aborigines traditional diet consists of roots and vegetables high in fiber. When white flour and sugar became their predominant source of dietary carbohydrates, combined with a sedentary life-style, high rates of obesity and diabetes, followed by hypertension and coronary heart disease (WHO. 1990:35), occurred.

1.3.2.1. CARDIOVASCULAR DISEASE

The most frequent cardiovascular diseases include atherosclerosis, arterial thrombosis and hypertension.

Cardiovascular disease as a public health problem became evident in Europe and North America early in this century and could have been avoided through appropriate lifestyles of eating and physical activity. It has however, become the single major cause of adult death and morbidity in "western" industrialized countries (Nestel, 1994:216; WHO, 1990:55).

Although other factors are also involved, the risk of cardiovascular disease in individuals is mainly increased by three major factors: high serum total cholesterol, high blood pressure and cigarette smoking. The presence of more than one of these risk factors increases the risk of the disease more than would be expected from the sum of the individual risk factors.

The fundamental role of diet in the development of cardiovascular disease is mediated through its effects on the development of hypercholesterolaemia and hypertension. Body-weight changes, as well as changes in diet and physical activity are strongly correlated to changes in serum total cholesterol and blood pressure (WHO, 1990:56).

High blood pressure is the main risk factor for stroke. Alcohol and excess salt intake also play major contributory roles (WHO, 1990:11) in the development of this disorder.

1.3.2.2. OBESITY

Another feature of dietary changes in developing countries, is the increased consumption of energy-dense items. This phenomenon, combined with a more sedentary lifestyle in the urban environment, can produce changes in body composition resulting in overweight and obesity (Solomons and Gross, 1995:93; Beyers et al., 1994:206). Obesity has proven to be one of the major risk factors for heart disease, stroke, diabetes and some cancers.

Although Truswell (1994:585) stress the fact that very obese persons have enhanced susceptibility to develop complications such as hypertension and diabetes (Riccardi, 1994:247), the data from the Framingham Heart Study done in the USA, indicate that being only ten percent overweight, could present risks for an individual's health (Sasson, 1990:160). Besides hypertension and diabetes, the results of obesity include high blood cholesterol, several types of cancer and heart diseases (Beyers et al., 1994:206; Sasson, 1990:160).

Consequently, the approach for overweight correction should be based on a population strategy, especially in communities where the traditional undernutrition is replaced with overnutrition (Solomons and Gross, 1995).

1.3.2.3 TYPE 2 DIABETES MELLITUS

Type 2 Diabetes Mellitus is a chronic metabolic disorder where the body's capacity to utilize glucose from carbohydrate foods, body stores of glycogen or other sources is impaired. Diabetes is the most commonly documented disease in countries presently undergoing the nutrition transition (Binns et al., 1994:200).

This disease is strongly associated with an increased risk of coronary heart disease. Literature indicates that the risk of an obese person to develop diabetes is three times higher than for a person of normal weight. Thus, the relationship between obesity and diabetes need to be emphasized. Sasson (1990:164) states that this disease reduces life expectancy by one-third, while it doubles the risk of heart attack.

Although obesity is the major risk factor for the development of type 2 diabetes, a number of environmental factors within a community also trigger type 2 diabetes mellitus. These include sedentary life-style, qualitative and quantitative dietary changes, stress (Binns et al., 1994:200), urbanization and socioeconomic factors. Because of this, there is a continuing debate about whether all individuals could benefit from a low-fat, high-carbohydrate diet. Some concern is also expressed as to whether people used to an affluent diet can adjust to the major changes in diet advocated to overcome chronic diseases (WHO, 1990:67, 171).

1.3.2.4 CANCER

The relationship between specific dietary components and cancer are less well established than those between diet and cardiovascular disease. Although evidence indicates that dietary factors are important in the development of cancer and that dietary modifications may reduce cancer risk, the contribution of diet to total cancer incidence and mortality cannot as yet be quantified.

Nevertheless, a diet that is low in total and saturated fat, high in plant foods, low in alcohol, salt-pickled, smoked and salt-preserved foods is consistent with a low risk of many of the current major cancers, including cancer of the colon, prostate and esophagus (WHO, 1990: 67).

1.3.2.5. HYPERTENSION

Blood pressure is vital to life. The heart's pumping action must create enough force to push blood through the major arteries into the smaller arteries and finally into the tiny capillaries, whose thin, porous walls permit fluid exchange between the blood and the tissues. When the pressure is correct, the cells receive a constant supply of nutrients and oxygen and give up their wastes. Hypertension develops, when the pressure increases to levels that stress the heart, causing it to pump the blood against resistant arteries (Whitney and Rolfes, 1999:571).

Elevated arterial blood pressure, or hypertension, is a major public health problem throughout the world (Einhorn and Landsberg, 1988:1269) and the most common public health problem in developed countries (Mahan and Escott–Stump, 2000:596). Untreated hypertension leads to many degenerative diseases, the most common being cardiovascular in origin (Mahan and Escott–Stump, 2000:596). Although not considered a disease by itself, the presence of hypertension substantially increases the risk that a person will develop heart disease or kidney failure or will experience a heart attack or stroke (Brown, 1998:23-18).

Whitney and Rolfes, (1999:570) state that hypertension contributes to over a million heart attacks and half a million strokes each year in the USA. It is estimated that ten to twenty percent of adults worldwide may be at risk for development of hypertension (Brown, 1998:23-18; Lang et al., 1985). This involves nearly 5.5 million South-Africans, with the Black population as the major group, comprising three million (Engel, 1996:441).

The decline in cardiovascular disease mortality over the last two decades has partly been attributed to the increased detection and control of hypertension. Emphasis on life-style modification has resulted in diet playing a prominent role in both the primary prevention and management of hypertension (Mahan and Escott-Stump, 2000:596, 598).

i) BLOOD PRESSURE: DEFINITION AND CLASSIFICATION

Engel, (1996:442) defines normal blood pressure for adults as a measure between 100/60 mmHg to 130/80 mmHg. The average normal blood pressure measure is 120/80 mmHg. A general definition of hypertension is a systolic blood pressure (SBP) of 140 mmHg or above and/or a diastolic blood pressure (DBP) of 90 mmHg or higher (Mahan and Escott-Stump, 2000:596). A standard set by the WHO defines hypertension as 160/95 mmHg and considers less than 140/90 as normal. "Mild" hypertension is defined by an SBP between 179 and 160 mmHg and a DBP between 100 and 109 (Mahan and Escott-Stump, 2000:596).

The area between normal and high, which is considered "as risk," is associated with an increased chance of developing illness and dying, and thus warrants attention. Blood pressure of about ten to 15 percent of adults falls within this "at risk" range. Life-style changes without additional medication can result in decreased blood pressure in this group (Engel, 1996:442). Table 1.2 summarizes the classification of blood pressure for adults over age 18 (Mahan and Escott–Stump, 2000:554).

Table 1.2 Classification of Blood Pressure for Adults age 18 years and older (Mahan and Escott–Stump, 2000:554).

CATEGORY	**SYSTOLIC, mmHg**	**DIASTOLIC, mmHg**
Normal	< 130	< 85
High normal	130 – 139	85 – 89
Hypertension Stage 1 (mild) Stage 2 (moderate) Stage 3 (severe)	140 – 159 160 – 179 ≥ 180 ≥ 210	90 – 99 100 – 109 ≥ 110

In the Fifth Report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure, hypertension is classified in stages based on the risk of developing cardiovascular disease.

The defining point for hypertension is arbitrary since any level of elevated blood pressure is associated with increased incidence of cardiovascular diseases and renal disease. Therefore, normalization of blood pressure is important for all levels of hypertension (Mahan and Escott–Stump, 2000:597).

ii) HIGH RISK GROUPS

Although hypertension cannot be linked to a certain segment of the population, it appears that the salt sensitive group, the stage four hypertensive (systolic ≥ 210 mmHg and diastolic ≥ 120 mmHg), obese hypertensive (Mahan and Escott-Stump, 2000:599, 558), urbanized Black (Mahan and Arlin, 1992:338, 389) and Coloured people (Einhorn and Landsberg, 1988:1273) have an increased risk of developing hypertension. The male gender, until the age of 55, after which no gender differences exist (Mahan and Escott-Stump, 2000:597) and the elderly (Brown, 1998:23-19), also have an enhanced susceptibility to hypertension (Mahan and Arlin, 1992:389).

The National Heart, Lung and Blood Institute (NHLBI) Growth and Health Study (1992) indicates that elevated blood pressure is more prevalent in the Black population and is known to be associated with obesity. Einhorn and Landsberg (1988:1273) confirm that Blacks, as a group, appear to have an increased susceptibility to the hypertensive affects of sodium chloride.

The prevalence of hypertension rises with increasing age with 45 percent of the adult population between the age of 45 and 55 (Kapoor, 1995:159) and over half of the adult population older than 60 years suffering from hypertension (Mahan and Escott-Stump, 2000:597).

iii) MINERALS IN THE MANAGEMENT OF HYPERTENSION

It is widely accepted that certain dietary factors such as sodium, alcohol and overall energy intake influence blood pressure in normotensive and hypertensive individuals (Truswell, 1994:584; Beilin, 1994b:224). Research indicates, however, that other nutrients, such as potassium and calcium have also been associated with blood pressure (Obarzanek et al., 1996).

a) CALCIUM

The importance of calcium in the biochemical control of vascular muscle tone and blood pressure homeostasis has been recognized through the use of calcium channel-blocking agents for the treatment of blood pressure (Resnick, 1985; Einhorn and Landsberg, 1988:275).

Studies indicate that increasing calcium intake through supplements may lower blood pressure in subjects with essential hypertension. These results have been highlighted in studies where calcium supplements of 1500 mg/day resulted in a modest but significant decrease in blood pressure. These studies also suggest an increased calcium intake as primary treatment in the management of hypertension (Resnick, 1985; Lyle et al., 1987).

Despite the reported potential benefit of calcium in hypertension, single studies also indicate an inverse relation between dietary calcium intake and blood pressure (Resnick, 1985; Lyle et al., 1987; Bucher et al., 1996) in both sexes, with a stronger relation in women. The public health implications of these findings, may have considerable effects, since calcium intake in the general population is generally below current recommendations (Nordin et al., 1994:645).

The nutrition transition further tends to increase calcium requirements due to an increased intake of dietary sodium (Resnick, 1985) and dietary protein (Nordin et al., 1994:645). Calcium losses increase by about 1 mmol (40 mg) daily for every 100 mmol (2.3g) increase in sodium intake due to a diuretic effect. It is estimated that a forty gram increase in dietary protein intake, increases calcium loss by about 1 mmol (40mg), due to the effect of extra acid load (Nordin et al., 1994: 645).

Due to the heterogeneity of human hypertension and differences in the calcium metabolism of the various biochemical and clinical hypertensive subgroups, persons suffering from hypertension may not respond equally to calcium supplementation (Resnick, 1985; Hunter and Callaway, 1985; Cappuccio et al., 1995). For this reason, no specific dietary increase in calcium intake above the recommended dietary allowance should be made for the prevention or treatment of hypertension.

b) POTASSIUM

Epidemiological evidence suggests that potassium supplements result in a blood pressure lowering effect (Truswell, 1994; Whelton et al., 1997). This result has, however, not been found consistently. Potassium supplements have demonstrated an inverse relationship between blood pressure and potassium in certain subjects (Whelton et al., 1997). Although some studies have shown a fall in blood pressure in hypertensive patients on potassium supplements, little effect has been seen in normotensive persons or in treated hypertensives on a low salt diet (Beilin, 1994b). Thus, there are limitations to the applicability of dietary potassium in the management of hypertension.

If a sodium intake of 70 mmol/day is maintained, the hypotensive effect of potassium in certain subjects may be insignificant (Truswell, 1994:586). Thus, the decrease in blood pressure due to potassium intake may be due to the higher ratio of dietary potassium to salt, rather than the amount of potassium itself (Einhorn and Landsberg, 1988:127).

The potassium-trials that have been undertaken to decrease blood pressure have used potassium supplements at doses between fifty to 140 mmol per day, which is double the usual dietary intake. There are few foods rich enough in potassium to provide this intake through diet alone (Truswell, 1994:584). In contrast, the majority of meta-analyses done by Whelton et al., (1997) favour increased potassium intake for the treatment and prevention of hypertension.

c) **SODIUM**

The main focus of this study is related to salt and sodium intake, and thus a more detailed discussion on these minerals will follow in chapter 2.

Although the association between salt intake and illness was recorded many years ago (Simone et al., 1995), the relative importance of salt was not realized untill the mid nineteenth century when observations suggested that salt was linked to body fluid volume. Since then, salt has dominated the literature relating diet to hypertension (Einhorn and Landsberg, 1988:1272).

The first known effective treatment for hypertension was salt restriction. A reduction of salt in the diet was recommended in 1904 by Ambard and Beaùjard (Einhorn and Landsberg, 1988:1272) and in 1922 by Allen and Sherrill (Wilber, 1982). Interest accelerated during the 1940's with further reports that dietary restriction of salt could lower blood pressure, as well as with epidemiologic studies in societies where low blood pressure and low salt intake appeared to be related (Einhorn and Landsberg, 1988:1272).

In 1948, it was reported that a diet consisting solely of fruit and rice supplemented with vitamins would reduce the blood pressure to normal levels, with concomitant clinical improvement in patients with severe and malignant forms of hypertension (Wilber, 1982). Drastic sodium restriction (less than 400 mg per day) was the effective component of the "rice diet".

In the early 1950's, the first medications that have blood pressure lowering effects were introduced (Wilber, 1982). Henceforth, it has become standard therapy to advise patients to reduce their sodium intake as an adjunct to drug therapy in the treatment of hypertension. In the 1960's and 1970's, many new drugs were introduced including other diuretics that were found to be effective in lowering blood pressure. At that point, salt restriction in the treatment of hypertension was partly relegated to ancient history. During the 1980's the relationship between sodium and hypertension was re-evaluated (Simone et al., 1995) and resulted in a renewed interest in the role of diet modification for the treatment of high blood pressure. This represents a revival of an earlier therapeutic trend.

Epidemiological studies show that the great majority of hypertensive individuals are mildly hypertensive (diastolic 90 to 104 mmHg) (Wilber, 1982). Brown (1998:23-10) also indicates that about forty percent of all cases of hypertension are classified as mild. A large clinical trail, the Hypertension Detection and Follow-Up Program, undertaken by the National Heart, Lung and Blood Institute in America, has effectively demonstrated the success of treating high blood pressure with medication. Especially in the group with mild hypertension, treatment decreased total mortality by twenty percent. Although this information argues strongly in favour of treating all persons with high blood pressure with medication, it has also stimulated concern and controversy regarding the motivation for placing millions of patients on medication, perhaps for a lifetime with its expense and possible long-term risk (Friedewald, 1982; Wilber, 1982).

This concern has stimulated a renewed interest in finding non-chemical methods of controlling elevated blood pressure. Research interests have recently focused on non-pharmacological approaches to the control of hypertension and on efforts to prevent the development of the disease itself and not only the consequences thereof (Friedewald, 1982). The non-pharmacological approaches being investigated include various behavioural techniques, as well as two main nutrition intervention efforts – dietary sodium restriction (see chapter 2) and weight reduction (Friedewald, 1982; Wilber, 1982; Einhorn and Landsberg, 1988:1270).

Few long-term studies have been reported on the efficiency of dietary therapy in large numbers of patients. There has been confusion as to whether the blood pressure lowering effect is due to sodium restriction, weight loss or a combination of the two (Wilber, 1982). Population-based evidence of the importance of diet, however, has been amplified and confirmed by recent epidemiological studies in which data has been obtained from large numbers of individuals (WHO, 1990:11).

Scientific evidence continues to accumulate supporting the important role of diet in the development of the most common causes of premature death in developed countries: cardiovascular disease and cancer. The main risk factor for stroke – the leading cardiovascular disorder in many developing countries – is high blood pressure, in which obesity, alcohol intake and excess salt intake play major contributory roles (Shils et al., 1988:454; WHO, 1990:11).

The elderly are more susceptible to the hypertensive effect of salt, most likely because of diminished renal function (Einhorn and Landsberg, 1988:1273) and the losses in salt-taste perception (Schiffman, 1991), rather than genetic predisposition. Thus, blood pressure levels and salt intake are strongly correlated in the elderly (Einhorn and Landsberg, 1988:1273; Law et al., 1991b)

A recent study has demonstrated that a moderate degree of sodium restriction (6 g of salt or 100 mEq or 2400 mg sodium/day) can significantly lower systolic blood pressure in hypertensive subjects aged 65 – 79 years (Fotherby and Plotter, 1997). Available evidence also indicates that about twenty percent of the population with high blood pressure respond to levels of sodium that are progressively higher than the equivalent of three to five gram of salt. A comparison of mean population blood pressures and mean salt intakes in 27 populations has shown a convincing linear relationship of both systolic and diastolic blood pressure with salt intake. To reduce the potential impact of dietary salt on essential hypertension, the salt content of processed foods should be minimized and dietary sodium should not exceed the equivalent of five grams of salt per day (Scrimshaw, 1994:123).

Most of the evidence in favour of a role for sodium or the amount of salt in the development of hypertension (Cappuccio and MacGregor, 1997a); comes from epidemiologic data (Mahan and Arlin, 1992:389). It is a striking fact that hypertension is not found in all unacculturated societies, nor does the prevalence of hypertension increase with age in all civilized populations (Edward, 1976). Primitive societies in which the intake of sodium is low (70 mEq/day, I 3.8 g salt), experience low prevalence of hypertension, and the blood pressure increase associated with age and common in industrialized societies, does not occur (Mahan and Escott-Stump, 2000:601).

When unacculturated peoples who are free from hypertension increase their salt intake, blood pressure rises and hypertension appears (Edward, 1976; Mahan and Arlin, 1992:389). An investigation done in Zulu populations, indicated that hypertension occurs commonly amongst urban Zulus, while hypertension in the non-salt eating rural Zulu, is basically absent. This indicates that low salt intake results in low levels of hypertension in contrast to the high prevalence of hypertension when salt intake is higher. In epidemiological surveys of unacculturated peoples, the importance of salt has been emphasized as the leading factor determining the presence or absence of hypertension (Edward, 1976).

Stroke is directly related to blood pressure and treatment trails in older hypertensive individuals show a reduction in the prevalence of stroke. Mahan and Escott-Stump (2000:598) confirm that hypertension is prevalent and stroke is the leading cause of death in countries with very high salt consumption (9 to 12 g / day or 150 to 200 mEq sodium / day). However, the majority of strokes in older people occur below the current definition of hypertension in normotensive individuals in whom no attempt is made to lower blood pressure. A modest reduction in salt intake can lead to a decrease in blood pressure in both normotensive and hypertensive elderly (60 – 78 years) (Cappuccio et al., 1997b). For this reason many health-related organizations have recommended reduction in sodium intake for the general public, both healthy and ill (Lang et al., 1985). Witschi et al., (1985) indicates that even among youths, lowered sodium intake is being proposed in the hope that it may decrease the risk of hypertensive disease later in life.

Attention to dietary factors influencing chronic diseases must be complemented by strategies to combat the health risk due to obesity, low levels of physical activity and the use of tobacco (Scrimshaw, 1994:123). The association between hypertension and sodium intake further stresses the requirement for food processing technologies that use less salt and nutrition education strategies to promote decreased salt intake in home prepared meals (Scrimshaw, 1994:123).

The increasing prevalence of chronic diseases, especially hypertension, in South African communities undergoing the nutrition transition has prompted us to investigate the acceptability of food, primarily home-prepared products, low in sodium. The results of such a study could result in recommendations that can contribute to the prevention of hypertension and the development of remedial actions that can provide a cost-effective, conservative approach in the management of hypertension.

1.4. OBJECTIVE OF THE STUDY

The main objective of this study is to assess the magnitude of sodium reduction that can be made, without significantly changing the perception of saltiness or decreasing the acceptability of a broad range of home-prepared food items.

SUB-AIMS

- Systematically reduce sodium content in both simple and complex dishes, to determine:
    - Whether the perception of saltiness and food acceptability are associated with the sodium concentration.

- Whether the different food textures play a role in the perception of saltiness and the acceptability of the sodium concentration.
- If the perception of saltiness and acceptability with regard to the complexity of the food (based on the number of ingredients), differ.

- To determine whether acceptability and salt perception of salt varies between different age groups.

- To determine whether high salt users differ fundamentally from moderate and low salt users with regard to the perception and acceptability of the sodium levels in home-prepared foods.

1.5. SUMMARY

In South Africa, a developing country with a multi-cultural society moving through the demographic, epidemiological and nutrition transition, a need exists to understand the link between transition and chronic disease patterns. Progressive urbanisation and industrialization have been linked to changes in mortality and morbidity, characterized by a decline in infectious diseases and an increase in chronic diseases, typical of the Western population. Large segments of the South African population are presently in the process of urbanization. It is estimated that by the year 2010, seventy percent of South Africa's population will be urbanized, affecting mainly the Black population.

Food intake, choices, availability and supply and diseases of lifestyle, with hypertension as one of the most common public health problem in developing countries, are involved in the changing nutrition situation.

Emphasis on life-style, especially diet modification plays a prominent role in both the primary prevention and management of hypertension.

CHAPTER 2

LITERATURE REVIEW

2.1. INTRODUCTION

The association between salt intake and illness was first recorded 4500 years ago in the "Yellow Emperor's Classic of Medicine". Despite the thousands of studies – epidemiological, clinical, and experimental, the relative importance of sodium consumption in the prevention and treatment of hypertension remains controversial due to the multifaceted nature of hypertension that involves interaction between environmental and genetic factors (Simone et al., 1995).

Research done in the 1980's, re-evaluated the relationship between sodium and hypertension (Simone et al., 1995). In spite of the fact that a habitual high salt intake universally increases the risk of developing hypertension, certain segments of the population are considered salt-sensitive, because their blood pressure is more significantly affected by salt consumption (Mahan and Escott-Stump, 2000:602; Simone et al., 1995).

Hypertension is one of the most common illnesses in the world and untreated hypertension leads to many degenerative diseases, the most common being cardiovascular in origin (Mahan and Escott-Stump, 2000:596).

Although hypertension cannot be linked to a certain segment of the population, literature indicates that there are focus groups with enhanced susceptibility to hypertension, for whom a lowered sodium intake is proposed to decrease the risk of developing hypertensive diseases (Mahan and Escott-Stump, 2000:597, 599; Mahan and Arlin, 1992:338, 339; Einhorn and Landsberg, 1988:1273; Brown, 1998:23-19).

In spite of these identified focus groups, Witschi et al. (1985) indicates that even among the youth, lowered sodium intake is recommended to decrease the risk of developing hypertensive disease later in life. More recent information indicates that diets high in salt injure arteries and increase mortality in all sectors of the population (Simone et al., 1995). For this reason Witschi et al. (1985) emphasize the fact that reduction in the level of sodium in the diet may have beneficial effects. Data from several studies (Simone et al., 1995, Witschi et al., 1985; Norton and Noble, 1991) suggest that a decrease in dietary sodium may have favourable effects on cardiovascular disease, morbidity and mortality (Robinson et al., 1989:547), on condition that the rule of life-long sodium restriction will be maintained (Engel, 1996:442).

In response to the link between high sodium intake and hypertension, moderate restriction of salt intake has been proposed as a dietary goal for the general public (Bertino et al., 1982a; Lang et al., 1985).

Epidemiological studies support an etiologic role of salt in hypertension development. Primitive societies in which the intake of sodium is low (70 mEq/day, ± 3.8 g salt), experience a low prevalence of hypertension, and blood pressure increases associated with age, common in industrialized societies, do not occur (Mahan and Escott-Stump, 2000:601). Cappuccio and MacGregor, (1997a) confirm this from cross-cultural comparison studies where blood pressure levels tend to increase with age in societies where salt is added to food, but where no salt is added the pressure does not increase with age.

The recommendation to reduce salt intake (Law et al., 1991b; Simone et al., 1995; Witschi, 1985) to combat or delay the development of hypertension (Churchill, 1999) and to protect against vascular injury (Simone et al., 1995), age-related increase in blood pressure, and cardiovascular morbidity and mortality (Robinson et al., 1989:529), forms part of the dietary guidelines currently being proposed in Western industrialized nations (Harper, 1987).

These guidelines focus mainly on recommendations for prevention of chronic and degenerative diseases, which are the major causes of death in Western societies (Churchill, 1999).

2.2 SALT AND SODIUM

On the one hand sodium is a gift from the sea; on the other it is a hazard to health. Sodium's life- and health-sustaining functions are frequently overshadowed by its effects on blood pressure when consumed in excess (Brown, 1998:23-17).

2.2.1 DEFINITIONS

Sodium chloride, or salt, has been an important commodity throughout human history because of its properties as a preservative and taste enhancer (Einhorn and Landsberg, 1988:1272). Historically, salt was integral to trade routes and religious customs and was considered a favourite of the gods by Homer and Plato. To "sit above the salt", was a position of honour in which one could use as much salt as desired (Fregly and Fregly, 1982). To make a "covenant of salt" was to seal a bond among individuals (Einhorn and Landsberg, 1988:1272). At one time salt was considered a major currency. The word "salary" is derived from the Roman word "salarium", meaning an amount of salt paid to Roman soldiers (Robinson et al., 1989:141).

Salt has continued to be valued in the modern era (Engel, 1996:90). Recent concern, however, over the excessive use of salt in developed countries and its link to hypertension has generated much scientific and public controversy (Fregly and Fregly, 1982).

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Many people are confused about the difference between the term sodium (Na) and salt (sodium chloride). Sodium has often been considered, especially in the lay press, synonymous with salt, while most of the sodium controversy actually concerns salt (Fregly and Fregly, 1982). Sodium occurs in nature as an extremely reactive mineral. The most common chemical partner of sodium is chloride (Cl), and much of the sodium present on this planet is in the form of sodium chloride or table salt (Brown, 1998:23-17). Salt has a greater effect on blood pressure than either sodium or chloride alone or in combination with other ions (Whitney and Rolfes, 1999:376).

Salt is made up of forty percent sodium and sixty percent chloride, by weight (Kapoor, 1995:159; Brown, 1998: 23-17). This means that one gram of salt contains 0.4g of sodium, and conversely one gram of sodium is the equivalent of 2.5g of salt (Walker et al., 1997:300).

2.2.2 SOURCES OF SODIUM

The principal dietary sources of sodium as indicated by Mattes and Donnelley (1991) and Robinson et al., (1989:142, 549) include:

* Sodium inherent to food
* Discretionary salt use (i.e., table and cooking)
* Salt added during food processing
* Water and pharmaceuticals

2.2.2.1 SODIUM INHERENT TO FOOD

In studies undertaken by Pietinen (1982) and Mattes and Donnelly (1991) to determine the major sources of sodium in the diet, it is indicated that naturally occurring sodium constitutes about 13 percent of total sodium intake.

Of the different food groups, cereals and cereal products provide the highest proportion of the total sodium intake, namely twenty to thirty percent for adults (Shank et al., 1982). As indicated by an evaluation of the nutrient intake of urban Blacks from the dietary data in the BRISK study, the high proportion of sodium intake through cereals and cereal products is evidence of the traditional cereal based diet. The impact of westernization in the BRISK study was evident in that the intake of refined cereals was substantially higher than unrefined cereals (Bourne et al., 1994).

Sodium derived from eggs, meat and fish constitutes 15 percent of total sodium intake (Pietinen, 1982). Robinson et al., (1989:549) indicate that the natural sodium content of animal food is relatively high compared to other foods and remains reasonably constant. Organ meats contain somewhat more sodium than muscle meat. Milk and milk products constitute about 11 percent of the total sodium intake (Pietinen, 1982). The Food and Drug Administration Total Diet Study on dietary sodium intake in the USA, also indicate that meat, fish, poultry and dairy products account for thirteen and ten percent respectively (Shank et al., 1982). Butter and margarine constitute about ten percent and bread about twenty percent of the sodium intake, while sausages and other processed meat products contain approximately 12 percent (Pietinen, 1982).

2.2.2.2 SALT ADDED: DISCRETIONARY SALT USE (table and cooking)

In most kitchens, salt is habitually added when cooking ingredients such as pasta, cereals, eggs, grains and vegetables in water. For most people it is a natural reaction to sprinkle salt in the water before cooking items like poached eggs, boiled rice, or blanched green beans. Some cooks attempt to enhance the flavour of dishes by simply adding salt rather than elevating the more natural flavour of ingredients in dishes (Kapoor, 1995:160). This may clarify why the main source of sodium in the diet, except for sodium added during food processing, is the salt added in food preparation – between 35 and 41 percent of the total sodium intake (Pietinen, 1982; Cappuccio and MacGregor, 1997a). Table salt contributes between four and ten percent (Simone et al., 1995).

2.2.2.3 SALT ADDED: FOOD PROCESSING

Prepared foods that have been extensively processed are important sources of sodium (Norman, 1990:441) and typically contain far more sodium than their fresh counterparts. Moreover, processed foods can be high in sodium without tasting salty (Kapoor, 1993:166). Data indicates that processing-added sodium contributes about 33 to 77 percent of total sodium consumption (Simone et al., 1995; Mattes and Donnelly, 1991; Cappuccio and MacGregor, 1997a).

Salt is a highly effective flavour enhancer (Crocco, 1982) and is added to processed foods to season and to preserve. Salt is also used by the food processing industry for certain technical reasons e.g., as a curing agent, as a formulating and processing aid, and as a conditioner of dough by the baking industry (Fregly and Fregly, 1982:3).

Thus, in many instances, salt and other sodium containing substances are technologically necessary in the preparation of foods for commercial sale. Since it will take time to develop alternate ingredients or technologies (if they can be developed at all), the importance of noting the sodium content on the labels of processed foods must be stressed (Crocco, 1982).

2.2.3. REQUIREMENTS

Sodium is a mineral essential to the life of man and necessary for the body to perform optimally (Kapoor, 1995:159). The functions of sodium in the body include the maintenance of the normal body fluid and electrolyte balance (Whitney and Rolfes, 1999:375). It also assists in nerve impulse transmission and muscle contraction (Brown, 1998:23-10). It is needed to maintain the correct acid-base balance in body fluids and to help maintain an appropriate amount of water in blood and body tissues (Mahan and Arlin, 1992:141).

Deficient intake of sodium may lead to the symptoms of potential low-sodium syndrome. These symptoms include muscle cramps, mental apathy, loss of appetite (Whitney and Rolfes, 1999:378) as well as headache, swelling, weakness (Brown, 1998:23-10), abdominal cramps and aching skeletal muscles (Mahan and Arlin, 1992:554, 142).

During severe sodium restriction, care should be taken to avoid hyponatremia, hypochloremia, and eventually azotemia as the glomerular filtration rate falls (Mahan and Arlin, 1992:576).

The ideal amount of dietary sodium has not been fully defined with the requirement depending on genetic factors and climate, among other factors. The total daily need in man is, however, remarkably low (Fregly and Fregly, 1982). According to Robinson et al. (1989:141) 115mg sodium per day is needed to maintain the sodium balance of the body. Although a daily intake of 1,100 to 3,300 mg sodium has been labeled safe and adequate for adults by the Food and Nutrition Board of the National Academy of Science, a need for 250mg or less has been demonstrated in some population studies (Lang et al., 1985). Robinson et al. (1989:141) recommend 500mg per day for healthy adults; 120 – 200mg per day for toddlers and 225 to 400mg for children. The American Heart Association recommends 3,000 milligrams of sodium per day, or about one and a third teaspoons of salt a day provided this is the only source of sodium in the diet (Kapoor, 1995:160).

NAS-NRC (The Food and Nutrition Board of the National Academy of Science – National Research Council) have re-evaluated the recommendations and recommend an intake of six gram or less salt per day, which is equivalent to about 2,400mg sodium (Norton and Noble, 1991), based on the potential role of sodium in the development of hypertension (Mahan and Arlin, 1992:146). Forsythe and Muller (1980:227) state that a salt intake of 11.4 gram per day, will probably lead to an increase in the incidence of hypertension.

2.2.4 AVERAGE SODIUM AND SALT INTAKE

Several studies indicate that the average intake of sodium is between 5.5 gram and 17.5 gram per day (Robinson, 1989:142; Norton and Noble, 1997). This is equal to 2,500 to 2,600 mEq or approximately 1,776mg sodium per 1,000 kcal, or an average daily intake of 3,105 to 4,600 mg (Lang et al., 1985) plus an additional twenty percent as added salt (Norton and Noble, 1991).

As part of an evaluation undertaken by an Expert Panel on Nutrition Monitoring, it was established that sodium intake exceeds recommended levels in almost all age and sex groups (Mahan and Arlin, 1992:283). Beauchamp et al. (1982) also indicate that salt is consumed in excess of sodium requirements with some subjects consuming more than twenty times the prescribed requirement for sodium; far in excess of physiological requirements (Robinson et al., 1989:142).

Salt is consumed in such large amounts because it is present in so many processed foods and is difficult to avoid (Beauchamp et al., 1982). Consumption data gathered indicate that foods, including commercially processed foods, provide about 55 percent of the total sodium intake: food preparation provides between 35 percent and 41 percent, table salt contributes between four percent and ten percent (Simone et al., 1995) and 33 percent to 77 percent of sodium consumed (3165 mg sodium per day) (Mattes and Donnelly, 1991) originates from processed foods (Beauchamp et al., 1982). Thus, food preparation and use of commercially prepared foods are the areas in which sodium levels can be altered and where reductions of sodium intake can possibly be achieved.

Since few diets lack sodium (Kapoor, 1995:159), this increased consumption of sodium reflects an acquired taste for salt (Robinson et al., 1989:142). Evaluation of questions on salt preferences in a study undertaken by Bourne and her group (1993), show evidence of a tendency towards salt-seeking behavior. Beauchamp et al., (1982) suggest that the sensory pleasure derived from the taste of salt is the critical factor.

Thus, much of the salt that individuals and manufacturers place in foods is present because people "like" the taste of salty food better than the taste of the same food without salt (Beauchamp et al., 1982).

2.2.5. SODIUM RESTRICTION

Although previous epidemiological studies of isolated populations suggested an association between dietary salt intake and blood pressure levels, the evidence for a broad impact of salt on blood pressure of the general population has not been established until recently.

One reason for the difficulty in demonstrating a definite relationship between salt and blood pressure in Western societies, may be the heterogeneity of societies. One of the current hypotheses is that some population subgroups are genetically susceptible to hypertension, and only in these subgroups does a strong correlation between salt intake and hypertension exist (Einhorn and Landsberg, 1988:1272). These segments of the population are called salt–sensitive, because their blood pressure is affected by their salt consumption (Mahan and Escott-Stump, 2000:602; Simone et al., 1995). Norman (1989:473) indicates that the population subgroups which are genetically susceptible to hypertension, the elderly, the obese, the black population and those with renal insufficiency, might also be expected to be more sensitive to sodium.

Although still not understood clearly, Altschul and Grommet (1980) explain that the mechanism of sodium sensitivity is based on the way in which sodium affects the vascular system or the smooth vascular muscles.

Presently, salt-sensitive is defined as ≥10 mmHg decrease in blood pressure by salt depletion after salt loading or a more than five percent increase in blood pressure during salt repleting after restriction (Mahan and Escott-Stump, 2000:602). According to a study done by Fujita et al. (1980:210) patients are classified as "non-salt-sensitive" or salt-resistant when the average mean blood pressure value on the seventh day of a high-sodium diet either fell, remained unchanged or increased by less than ten percent.

Approximately thirty to fifty percent of hypertensives and 15 to 25 percent of normotensives are salt-sensitive, which means that a reduction in sodium intake beneficially influences blood pressure (Mahan and Escott-Stump, 2000:602). The rest, comprising 50 to 70 percent of hypertensive subjects and 75 to 85 percent with a normal blood pressure, are resistant to the effect of sodium reduction on blood pressure (salt-resistant) (Simone et al., 1995).

More recent studies, re-evaluating the relationship between sodium and hypertension (Simone et al., 1995), indicate that high salt intake increases the risk for the development of hypertension. Furthermore, dietary sodium intake in Western countries originates mainly from salt intake and many clinical trails have investigated the effect of reduction in dietary salt on blood pressure (Law et al., 1991b).

Although there is excellent epidemiological evidence in salt-sensitive individuals that high sodium intake is associated with the development of hypertension, the identification of salt-sensitive individuals is not always practical (Shils and Young, 1988:1293) and currently methods for identifying these individuals are lacking (Mahan and Escott-Stump, 2000:602).

Research indicates that diets high in salt injure arteries and increase mortality in salt resistant rats (Simone et al., 1995). Even though a high-salt diet did not affect blood pressure in these animals, the authors (Simone et al., 1995) suggest that salt-resistant patients may protect themselves from vascular injury by reducing their salt intake. This finding is supported by Witschi et al., (1985) who stress the fact that a reduction in the level of sodium in the diet may have beneficial effects for the population as a whole.

Thus, despite the controversy about, and the complexity of the relationship between sodium intake and blood pressure, data from several studies (Witschi et al., 1985; Norton and Noble, 1991) indicate that a decrease in dietary sodium may favourably affect vascular injury (Simone et al., 1995), age-related increases in blood pressure (Mahan and Arlin, 1992:385), and cardiovascular morbidity and mortality (Robinson et al., 1989:529, 547). The condition for these benefits is the maintenance of life-long sodium restriction (Engel, 1996:442).

Law et al., (1991a) in his study to estimate the quantitative relation between blood pressure and sodium intake, has shown that blood pressure varies according to sodium intake in all age groups and for people with both high and normal levels of blood pressure. Change in blood pressure for a given change in sodium intake, thus depends on a person's age and existing blood pressure levels. They found that a difference in sodium intake of 100 mmol/24h was associated with an average difference in systolic blood pressure that ranged from 5 mm Hg at age 15 to 19 years to 10 mmHg at age sixty to 69. The differences in diastolic blood pressure were about half as great.

The association between blood pressure and sodium intake in individuals is related to initial blood pressure levels. The higher the blood pressure, the greater the expected reduction in blood pressure for the same reduction in sodium intake. Law et al., (1991a) concluded that the association between blood pressure and sodium intake is substantially larger than is generally appreciated and increases with age and initial blood pressure levels.

In response to the epidemiological- and experimental data linking high sodium intake with hypertension in susceptible individuals, moderate restriction (six gram of salt or 100 mEq or 24 000 mg sodium /day) of salt intake has been set as a dietary goal (Mahan and Escott–Stump, 2000:602; 607; Bertino et al., 1982a). Many health-related organizations have recommended reduction in sodium consumption for the general public, both healthy and ill (Lang et al., 1985), but even salt-resistant persons may protect themselves from vascular injury by reducing their daily salt intake (Simone et al., 1995).

In contrast to what was previously thought, more recent studies that have compared the fall in blood pressure over a twelve–month period in four groups of hypertensive patients (diastolic 95 to 109 mm Hg), indicate that even mild sodium restriction (sodium intake reduced to 70 to 100mEq) produces a modest but definite fall in blood pressure. This study indicates that even though the decrease in blood pressure in patients treated only with a restricted sodium diet was not as great as that in patients treated with drugs, the decrease was sufficient to reduce the blood pressure to normal in many of these mildly hypertensive individuals. The fall in blood pressure with sodium restriction was slow and gradual and continued throughout the two-year period (Wilber, 1982).

From an epidemiological viewpoint, a reduction of only a few mmHg in mean blood pressure can demonstrate a decrease in risk from complications of hypertension. Therefore, the potential contribution to public health of widespread reduction of dietary sodium may prove of value (Einhorn and Landsberg, 1988:1273). In people age fifty to 59 years a reduction in daily sodium intake of 50 mmol (about three gram of salt), attainable by moderate dietary salt reduction would, after a few weeks, lower systolic blood pressure by an average of 5 mmHg, and by 7 mmHg in those with high blood pressure (170 mmHg). It is estimated that such a reduction in salt would reduce the incidence of stroke by 26 percent and ischaemic heart disease by 15 percent (Law et al., 1991b).

During the past several years, authorities in nutrition and public health have concluded that a positive correlation exists between sodium intake and hypertension (Shank et al., 1982). The Committee on Diet and Health (Mahan and Arlin, 1992:389) and the Food and Nutrition Board of the National Research Council have concluded that blood pressure levels are strongly and positively correlated with the habitual intake of salt (Simone et al., 1995).

2.2.5.1. SODIUM RESTRICTED DIETS

In addition to the healthy people who decrease salt intake to prevent hypertension, many individuals follow sodium restricted therapeutic diets for a variety of medical problems. In fact, sodium restricted diets are among the most prevalent therapeutic diets prescribed. In America community physicians report that a sodium restricted diet is by far the most widely prescribed diet for free-living individuals with medical problems (Kris-Etherton et al., 1982).

It would be incorrect to label a diet as "salt free", "low salt", "low sodium" or "sodium restricted", since any amount of sodium below the usual sodium intake would satisfy such a description, but would not necessarily be at therapeutic levels (Robinson et al., 1989:548).

The normal diet is usually modified for sodium content, in three levels of sodium restriction (Table 2.1).

Table 2.1 Sodium restricted diets (Adapted from Bloch and Shils, 1988:1561; Mahan and Arlin, 1992:572; Robinson et al., 1990:549).

Degree of restriction:	Strict
Sodium in mg	500 to 700 mg
Sodium in mEq	21.7
Salt in g	1.2
Degree of restriction:	Moderate
Sodium in mg	1000 to 1500 mg
Sodium in mEq	43.3
Salt in g	2.5
Degree of restriction:	Mild
Sodium in mg	2400 – 4500
Sodium in mEq	104.3 – 195.6
Salt in g	6.1 – 11.5

The degree to which sodium is restricted depends on the needs of the individual. A restriction in sodium levels of 500 mg/day or less (strict sodium restriction), will rarely be prescribed and then only for short periods (Mahan and Arlin, 1992:572), because these diets are potentially inadequate nutritionally.

Simone et al., (1995) indicate that if sodium levels are severely restricted (more than fifty percent), twenty percent of the sodium is likely to be added again as table salt. This may be the reason why a reduction of just thirty percent (Witschi et al., 1985) or a moderate restriction of salt (six gram or 100 mEq) (Mahan and Escott-Stump, 2000: 602, 607) intake has been set as a dietary goal (Bertino et al., 1982a).

The Food and National Board has stated that the level of sodium prescribed should involve the least amount of restriction necessary to achieve the desired clinical response (Robinson et al., 1989:549). A mild sodium restriction is suggested for those with a strong family history of hypertension or patients with borderline hypertension (Robinson et al., 1989:547). A number of health-related organizations have, however, recommended reductions in sodium consumption for the general public (Lang et al., 1985).

2.2.5.2. CHARACTERISTICS OF SODIUM RESTRICTED DIETS

Many individuals following sodium restricted diets, have reported difficulties with compliance for two major reasons (Kris-Etherton et al., 1982). The two reasons proposed include, firstly, the fact that sodium restricted diets are considered bland and tasteless. Persons, who have used salt as a major spice in food preparation for a lifetime, find that its reduction or elimination makes food unpalatable (Kris-Etherton et al., 1982).

Salt restricted diets (Simone et al., 1995; Lang et al., 1985; Witschi et al., 1985) do not have to be unpalatable. Sensory studies have shown that salt restriction can be achieved by simple dietary manipulation (Law et al., 1991a), including cooking with as little salt as possible and avoiding highly salted and processed foods, and not adding salt to food at the table (Wilber, 1982). These measures are able to reduce sodium intake by about 50 mmol/24 h (about three gram of salt or thirty percent of the average daily intake) (Law et al., 1991a).

A few studies have shown that sodium levels can be reduced by thirty to forty percent, without affecting taste and consumer acceptability (Simone et al., 1995). In a study undertaken by Witschi et al. (1985) amongst students, an experiment was conducted to decrease sodium intake by thirty to forty percent. The overall student ratings of regular and reduced sodium products were almost identical indicating that the amount of sodium in prepared foods can be decreased by up to fifty percent without significant loss of taste and acceptability.

The second reason for poor compliance of a sodium restricted diet may be cost. Low sodium diets are more expensive than a regular diet if special low sodium products are purchased, but such products are not necessary. Instead, many items can be prepared at home without adding additional salt (Kris-Etherson et al., 1982).

Other studies, however, indicate that the cost of the low sodium diet containing home-prepared products does not differ notably from the cost of the regular diet (Kris-Etherson et al., 1982). Implementation of recommendations to reduce sodium intake without additional cost require knowledge of the general dietary sources of sodium and the use of exchange lists for sodium restricted diets.

2.2.5.3. REDUCING SALT AND SODIUM IN RECIPES

A general knowledge of the rules for recipe modification, together with guidelines for the appropriate interpretation of food labels, can contribute to improved compliance. Appendix A summarizes the key strategies that can be employed to meet the request for food with less salt or sodium (adapted from Kapoor, 1995:192; Robinson et al., 1989:142 and Whitney and Rolfes, 1999:379).

Since ingredients on labels are listed in descending order by amount from largest to smallest, salt or other sodium-containing ingredients appearing at the top of the list indicate that the product is likely to contain a significant amount of sodium (Kapoor, 1995:166). The AMA (American Medical Association), like many other organizations, has stated its support for the declaration of the sodium content per serving of food as part of the label information provided to consumers (Crocco, 1982). The term "salt free" on products does not necessarily guarantee that a product is low in sodium, since the food may have natural sodium or sodium-containing additives (Mahan and Arlin, 1992:575).

The HBPEP (The National High Blood Pressure Education Program) comments on sodium labeling of foods indicating that its absence is a barrier to effective discrimination between foods that are high in sodium content and those that are not (Crocco, 1982). Labeling of the salt content of foods is a vital public health objective (Law et al., 1991b). See Appendix B for nutrition labeling regulation (Kapoor, 1995:191).

If the role played by food texture and dish complexity in the perception of saltiness and acceptability of salt levels in food can be determined, food preparation and consumption can be modified and adherence to a sodium restricted diet may be improved. To date no recommendations regarding the influence of different textures and combinations of ingredients on salt perception and acceptability have been made.

Thus, it seems that the correct choice of flavourings, food texture and ingredients need to be considered in recommendations aimed at reducing sodium intake (Kris-Etherton, 1982).

2.3. SODIUM REGULATION: SENSORY ASPECTS

Despite the fact that little is really known about the reason for the preference for salty foods and literature indicates that a first step in reducing salt intake is to understand sensory control of ingestion. Regulation of salt intake in an organism which is in or near sodium deficit, needs to be distinguished from regulation of intake in an organism which has an apparent excessive sodium intake (Beauchamp et al., 1982).

2.3.1 TASTE AND SALT

Specialized sense organs on the tongue and soft palate and the upper third of the esophagus, the pharynx, the epiglottis and the larynx (Charley, 1988:29) contain the receptors for our sense of taste. Taste receptors are in the cell membranes of groups of about thirty to fifty cells clustered in a layered ball called a taste bud. The taste buds themselves are contained in specialized structures consisting of bumps and grooves on the tongue (Beauchamp et al., 1982), and when these receptors are chemically stimulated the five primary sensations, sweet, sour, salty, bitter and “umami” (described as meaty and savoury) are detected (Kafka, 1999). Four different pairs of nerves innervate the tongue to make contact with these structures in the oral-pharyngeal area (Beauchamp et al., 1982).

Saliva plays an important role in taste function, both as a carrier of the dissolved molecules to the receptors and because it contains substances capable of modulating taste responses. Recent suggestions indicate that salivary glutamate may be capable of altering food flavour perception (Lawless and Heymann, 1998:41).

Although sensory responses to salt are primarily due directly to its taste, salt also stimulates salivation at higher concentrations. As a consequence, salt may, in some food, serve to make mastication and swallowing easier. Most other salts also have multiple tastes, but the most potent stimulus for salt taste is salt, although lithium chloride (a poison) also tastes quite salty, but with a bitter component (Beauchamp et al., 1982).

In the past, there has been debate as to whether the perceptual experience human beings describe as saltiness is due to the anion (Cl^-) or the cation (Na^+) (Bartoshuk, 1980:84). The traditional viewpoint implies that the tastes of sodium sensations can fall within the salty, sweet, sour and bitter taste ranges (Schiffman, 1980:99, 100). Thus, salts produce complex tastes and the ability to analyze the taste of salts into salty, sweet, sour, and bitter components, led to the attempt to attribute taste qualities to particular anions, cations or undissociated molecules (Bartoshuk, 1980:83).

Present behavioural evidence indicates that saltiness is produced by cations. A variety of simple cations (e.g. K^+, NH^{+4}) evoke bitterness as well as saltiness. The chloride anion adds no additional taste, but generally inhibits the effects of cations. Electrophysiological evidence supports this view, since cations elicit similar responses, whereas anions do not (Bartoshuk, 1980:85; Beauchamp et al., 1982; Charley, 1988:32).

Additionally, cations and anions may have other tastes which are concentration dependent. Both anions and cations are capable of evoking bitterness and sometimes sweetness when their structures contain groups associated with those qualities. At very low concentrations, salt tastes sweet (Lawless and Heymann, 1998:46). This is probably due to stimulation of the receptors that mediate sweet perception rather than the stimulation of receptors mediating salt perception (Beauchamp et al., 1982). Other evidence suggests that the sweetness of dilute salt is produced by water of hydration around the Na+ ions, such that they produce the structure required for sweet taste perception (Bartoshuk, 1980:86).

Lawless and Heymann (1998:44) suggest that one of the functional properties of taste function includes the tendency for mixtures of different tastes to show partially inhibitory or masking interactions. Some of these mixture inhibition effects, like the inhibition of bitterness by sweetness, appear to reside in the central nervous system, while others, such as the inhibition of bitterness by salt, are more likely due to peripheral mechanisms at the receptors themselves.

Hyper-additive effects, or enhancement, imply that there is a higher taste intensity in the mixture than would be predicted on the basis of simple addition of component effects. Enhancement is seen with sweetness from salt in low concentrations added to sugar. Salt has an intrinsic sweet taste that is normally masked by saltiness at higher levels. So the small increase in sweetness noted with addition of salt is due to this intrinsic sweet taste of dilute salt. This may explain the beneficial effects of small amounts of salt in food, or effects like the improvement in the taste of melons with light salting (Lawless and Heymann, 1998:46).

2.3.2 DIETARY SODIUM AND SALT PREFERENCE

Animal studies and human case report, conclude that, in sodium deficiency, taste preference for salt changes in an adaptive manner, followed by moderate sensory changes. In rats, electrophysiological and behavioural evidence suggests that a change in sensitivity occurs along with the change in preference, thus suggesting that sodium depletion leads to a decrease in the sensitivity to the taste of salt (Bertino et al., 1982b:146; Bertino et al., 1982a Beauchamp et al., 1982; Beauchamp et al., 1990).

In human beings, there also appears to be a sensitivity change with sodium deficit. Adults, placed on very low sodium diets; are able to detect lower concentrations of salt in water than adults eating higher sodium diets, that is they become more sensitive to sodium chloride (Beauchamp et al., 1982). The mechanism by which increased sensitivity could increase preference remains unclear.

Beauchamp et al., (1982) hypothesized that if a low sodium diet is followed, higher concentrations of salt in food will become more intense and less pleasant. This hypothesis is based on two lines of reasoning: Firstly, anecdotal reports have indicated that, after individuals have been on a low sodium diet, foods that used to taste just salty enough become too salty (Bertino et al., 1982a). That indicates that adaptation to salt has taken place.

Adaptation to salt has two important effects on the taste of salt. Initially, salt is salty only at concentrations above the adapting concentration. Thereafter, concentrations below the adapting concentration evoke a bitter-sour taste that increases in intensity as the concentration decreases (Bartoshuk, 1980:87; Lawless and Heymann, 1998:44). These results are to be expected on the basis of electrophysiological data that show that the stimulus for the salty taste of salt is absorption of sodium ions to the taste receptor membrane. When the concentration of sodium ions is constant, adaption occurs and the salty taste sensation virtually disappears. To re-evoke a salty taste, the concentration of sodium on the tongue must be increased (Bartoshuk, 1978).

This adaptation to a certain sodium concentration, because of the habitual intake of the same concentration level, differs from partial adaptation which occurs because of the complexity of the media in which the sodium concentration is presented and which gradually changes as chewing proceeds. Another form of adaptation which also occurs because of the complexity of the media in which the sodium concentration is presented, is considerable cross adaptation, usually found between compounds with similar taste qualities (Kroeze, 1990:48, 49).

Secondly, experimental studies have demonstrated that the context within which a taste is presented also influences the saltiness of that taste. If a low sodium diet is viewed as a situation in which many low sodium foods are tasted, then higher salt concentrations would be predicted to be judged more salty and less pleasant (Bertino et al., 1982a).

Murphy (as cited by Murphy and Gilmore 1990:27) demonstrated effects of context within which a taste is presented on the pleasantness of chemosensory stimuli, and indicates that exposure-related pleasantness shifts occurring over a lifetime could result in altered food preferences, especially in the elderly.

In contrast, studies reported by Beauchamp et al., (1982) indicated that subjects on a low sodium diet judged high concentrations of salt in soup as tasting less intense and more pleasant. In another study, sodium depleted subjects subjectively reported an increased desire for food higher in salt and exhibited a tendency to judge higher amounts of salts in food as most preferred (Beauchamp et al., 1990).

An increase in salt intake would serve to ensure that sufficient sodium is consumed to restore the deficit. In our society, however, the degree of depletion induced in above studies (10mmol/d) is unlikely to occur, except in extremely rare cases (Beauchamp et al., 1990). In long-term studies in which individuals were required to maintain low sodium diets for two to five months, results clearly demonstrate that, with longer periods of lowered dietary salt intake than the three weeks of restriction usually applied in studies, food with higher concentrations of salt did become less pleasant (Beauchamp et al., 1982; Bertino et al., 1982a; Bertino et al., 1982b:150). There is also a psychological mechanism that functions in direct opposition to the effect of deficiency on the taste of salt. Humans tend to judge sensory stimuli, including tastes, in terms of the contextual situation.

Ratings of the intensity and pleasantness of a particular taste can be changed by manipulating the context by varying the frequency of presentation of various taste stimuli. If high concentrations of salt in soup are presented more frequently than low-concentrations, a particular high concentration will be rated as tasting less intense and more pleasant (Bertino et al., 1982b:150).

This psychological mechanism can possibly be associated with changes in dietary and nutrient intakes that occur during urbanization, acculturation or westernization (Voster et al., 1995). It also explains the "salt-seeking" behaviour that occurs, after adapting to the westernized lifestyle and diet (Bourne et al., 1993).

When substances with different taste qualities are mixed, the perceived intensities are usually altered (Bartoshuk, 1980:95). When mixtures are constructed from substances with different taste qualities, most salts evoke more than one quality and the salty stimuli presented in simple aqueous or more complex food systems, yield different results (Simone et al., 1995; Mattes, 1987:133). Bertino et al., (1982a) observed changes in the taste of salt after several weeks of subjects maintaining a low sodium diet. Specifically, the rated intensity of salt in a solid food increased and the concentration that produced maximum pleasantness of salt in liquid food, such as soup, decreased.

Reduced salt preference may be important in maintaining reduced sodium intake. A reduction in breakpoint concentrations (concentration of maximum pleasantness) is likely to reduce sodium intake. A reduction in breakpoint concentration of 0.06 salt in soup, translates to a reduction of 327 mg sodium per cup of soup. Reduced salt preference may also be effective in individuals who initially have high salt preferences, since perceived saltiness increases as the log of the salt concentration increases. A small preference shift at high levels of perceived saltiness, may produce a greater sodium reduction in the diet than an equivalent preference shift at lower levels of perceived saltiness (Bertino et al., 1982a).

2.3.3 AGE AND TASTE SENSITIVITY AND PREFERENCE

Developmental studies of salt taste perception have been advocated in relation to the public health problems arising from over ingestion of salt.

2.3.3.1 INFANTS AND CHILDREN

There is abundant evidence that human infants are responsive to most taste stimuli from birth (Cowart, 1981), but neutral to salt (Einhorn and Landsberg, 1988:1273). This taste development and experience with tastes begins prematurely (Beauchamp et al., 1982; Einhorn and Landsberg, 1988:1273) because a variety of tastes are transmitted to the fetus through the amiotic fluid (Kafka, 1999). The diversity of the responses that have been observed suggests that taste is an especially potent stimulus for the infant (Cowart, 1981). Development studies summarise that newborn infants and young children tend to be indifferent to or dislike moderate to strong saline solutions (Beauchamp et al., 1982).

As the stimulation from the environment increases, the roll it plays in the development of sensory and perceptual functioning also increases. Kafka (1999) indicates that the ability to detect salty, umami and bitter tastes continues to develop. This indicates that the schedule according to which foods high in salt are introduced to infants is important (Weiffenbach, 1980:14). As early as two years of age, salt in some foods potentiates the intake of those foods (Einhorn and Landsberg, 1988:1273). It is suggested that the reason for this is related to a preference for the salty taste in association with the food ingested (Beauchamp et al., 1982). Children do seem attracted to salt, depending on the medium in which salt is tasted. It is also believed that high/additional salt ingestion is a consequence of habits learned during development (Bertino et al., 1982b:148). There is evidence to suggest that the age at which an individual is exposed to a high sodium intake may be important (Ellison et al., 1982).

Artificial milk formulae provide two to three times more salt that human milk. Early introduction to solid foods, especially homemade foods salted according to the family's taste, increases salt consumption during the first year. Beyond infancy, cultural and ethnic food traditions determine food choice and variety as children adapt to the high salt intake of the adult population (Weiffenbach, 1980:25).

Severe hypertension and its sequelae of heart failure, coronary diseases and stroke are very rarely seen in children. However, studies indicate that the upper fifth percentile of healthy American young people have pressures exceeding 140 mmHg systolic or 90 mmHg diastolic by the fourteenth or fifteenth year of age, and blood pressure generally continues to increase with age (Ellison et al., 1982). Thus, there is increasing evidence that childhood may be an appropriate time to consider measures for the prevention of hypertension later in life (Ellison et al., 1982).

In South Africa the mean daily sodium intake of males, age group fifteen to eighteen is 2025 mg (Bourne et al., 1993). Thus the first step in prevention of the development of hypertension later in life must start by avoidance of the high sodium diet, that is common in Western culture, to prevent children from acquiring the habit of eating salted foods (Freis, 1976).

2.3.3.2 THE ADULT AND ELDERLY PERSON

Schiffman (1991) indicates that there is a progressive decline in taste and smell sensitivity with advancing age. This loss of sensitivity reaches statistical significance at approximately sixty years of age and becomes increasingly severe in persons over seventy years of age. The decline in taste in the elderly results from normal aging, medication, certain illnesses and even environmental factors such as pollution (Kafka, 1999).

Some investigators have examined threshold sensitivity (the threshold being the point at which an observer first responds to a stimulus) (Lawless and Heymann, 1998:808) in relation to taste. They found that sensitivity to sweet, salty, bitter and sour tastes declined after the age of sixty. In another study subjects 48 to sixty years of age, were less sensitive than young adults and a fairly large proportion of the older subjects could recognize only the highest concentration of the salty taste presented (Cowart, 1981). Psychophysical studies of taste perception in elderly persons have found decreased taste perception at both threshold and suprathreshold concentrations (Schiffman, 1991).

Suprathreshold refers to the evaluation in a range clearly above the threshold, as in scaling intensity along the full dynamic range of a stimulus (Lawless and Heymann, 1998:807).

Schiffman and colleagues (1991) have found that the average detection threshold for elderly persons was an average loss of 5.41 (mean detection thresholds for sodium salts at pH 7.0) to a wide range of compounds (11.58 times higher for sodium salts and 5.04 times higher for glutamate salts).

Even in the absence of threshold changes, there may be changes in the perceived intensities of suprathreshold stimuli that could provide insight into the taste difficulties experienced by older people (Cowart, 1981). It has been found that the elderly have a reduced ability to discern intensity differences between various concentrations of salts. At moderate concentrations, young subjects require a change in concentration of approximately six to 12 percent to distinguish an increment in intensity for salts, such as sodium chloride. For elderly subjects, a difference of 25 percent or more was generally necessary to distinguish a difference (Schiffman, 1991).

Bartoshuk (1978) has proposed that psychophysical functions may become flattened with age. If functions for various tastes are differentially flattened, the perception of the taste of mixtures could be distorted, thereby causing food to seem less pleasant. Changes in the condition of the oral cavities of the elderly could also differentially affect the perception of solid foods (Cowart, 1981).

Literature also indicate the olfactory system also contribute to the awareness of taste. When food is placed in the mouth, taste information (e.g. sweet, sour, bitter and salty) is perceived as well as olfactory and trigminal information from the volatiles in food. These volatiles stimulate the olfactory system and add additional chemosensory stimulation (Murphy et al., as cited by Murphy and Gilmore, 1990:20). Thus, age-related olfactory loss together with psychophysical functions that may become flattened with age, may thus play a major role in flavour perception for the elderly.

The taste losses found in elderly subjects can have medical consequences for certain subsets of the population. Losses in salt-taste perception can make it difficult for hypertensive patients to comply with a low-sodium diet (Schiffman, 1991). Data shows that over half of the elderly population is hypertensive and cardiovascular disease risk in the elderly is two to three times higher than in middle aged populations (Mahan and Escott-Stump, 1996:554).

2.4. THE SCIENCE OF SENSORY EVALUATION

Sensory evaluation involves the development and use of principles and methods for measuring human responses to food (Sidel et al., 1981) and minimizes the potentially biasing effects of brand identity and other information influences on consumer perception (Lawless and Heymann, 1998:2). These principles and methods have broad application for a variety of products including foods, beverages, tobacco, home care, and personal care products. The common element is the use of humans as evaluators (Sidel et al., 1981).

Sensory evaluation has been defined as a scientific method used to evoke, measure, analyze and interpret those responses to products as perceived through the senses of sight, smell, touch, taste and hearing (Committee of the IFT Sensory Evaluation Division, 1981; Lawless and Heymann, 1998:2; Campbell, et al., 1980:433; Stone and Sidel, 1993:12; Charley, 1988:5).

The principles and practices of sensory evaluation involve each of the four activities mentioned in this definition. The science of sensory evaluation relies on guidelines for the preparation and serving of samples under controlled conditions so that biasing factors are minimized. Sensory evaluation is a quantitative science in which numerical data are collected to establish lawful and specific relationships between product characteristics and human perception. Proper analysis of data is a critical part of sensory testing. Data generated from human observers are often highly variable, and a panel of humans are by their nature a heterogeneous instrument for the generation of data. To assess whether the relationship observed between product characteristics and sensory responses are likely to be real, and not merely the result of uncontrolled variation in responses, statistics are used to analyze evaluation data (Lawless and Heymann, 1998:3). A sensory evaluation exercise is necessarily an experiment, and can be considered a science of measurement. Like other analytical test procedures, sensory evaluation is concerned with precision, accuracy, sensitivity and the avoidance of false positive results.

Common applications of sensory analysis as noted by Charley (1988:5) and the Committee of the IFT Sensory Evaluation Division (1981) include:

* New product development or reformulation
* Product matching
* Product optimization
* Process change
* Cost reduction and/or selection of a new source of supply
* Quality control
* Determining storage stability
* Product grading or rating
* Consumer acceptance and/or consumer preference and
* Correlation of sensory with chemical and physical measurements.

Consumer acceptance testing is a valuable and necessary component of sensory evaluation programs (Stone and Sidel, 1993:243). The measure of acceptability based on sensory properties of a product is logical and necessary before a product is marketed and substantial capital has been invested. In addition to its sensory properties, factors such as microbiological integrity, other safety factors and nutritional content, contribute to the perceived quality of a product (Lawless, 1991).

2.4.1 CLASSES OF TEST METHODS

Current sensory evaluation methods comprise a set of measurement techniques with established track records of use in industry and academic research. Sensory evaluation practitioners are concerned both with analytical specifications of perceived product differences as well as predicting consumer acceptance in the real world (Lawless, 1991). Sensory evaluation must thus ensure that the test method is appropriate to answer the questions being asked about the product in the test. These objectives have lead to two "styles" of performing sensory evaluation, namely Analytical (Type 1) and Affective (Type 2) sensory evaluation, in order to emphasize the differences in goals, orientation and methodological approach (Charley, 1988:5). For this reason, tests are usually classified according to their primary purpose and most valid use.

In Type 1 sensory evaluation, laboratory control is paramount, in order to maximize the sensitivity of the measuring instrument. In Type 2, the ability to generalize to the consuming public is of greater concern. Different types of panelists, serving procedures, sensory methods and statistical models for analysis may be chosen by the sensory practitioner, depending upon whether the objective of the test falls in the Type 1 or Type 2 class (Lawless, 1991). A summary of the Classification of sensory evaluation methods and panels is given in Table 2.2 (Committee of the IFI Sensory Evaluation Division, 1981)

Table 2.2: Classification of sensory evaluation methods and panels (Committee of the IFI Sensory Evaluation Division, 1981).

Classification of methods by function	Appropriate methods	Type and No. of panelist
ANALYTICAL: **Evaluates differences or similarity, quality and/or quantity of sensory characteristics of a product**		* Screened for interest, ability to discriminate differences and reproduce results * Trained to function as a human analytical instrument
Discriminative: ***Difference:*** Measures simply whether samples are different	Paired-comparison Duo-trio Triangle Ranking Rating difference/scalar Difference from control	* Normal sensory acuity * Periodic requalification * Panel size depends on product variability and judgement reproducibility. * No recommended "magic number" - a number often used is 10; a recommended minimum number is generally 5, since any fewer could represent too much dependence upon one individual's responses
Sensitivity: Measures ability of individuals to detect sensory characteristic(s)	Threshold Dilution	

Descriptive: Measures Qualitative and/or quantitative characteristic(s)	**Attribute rating:** Category scaling Ratio scaling (magnitude estimation) **Descriptive analysis:** Flavor profile analysis Texture profile analysis Quantitative descriptive analysis	
AFFECTIVE: **Evaluates preference and/or acceptance and/or opinions of product**	Paired-preference Ranking **Rating:** Hedonic (verbal or facial) Scale Food action scale	* Randomly selected * Untrained * Representative of target population * Consumers of test product * No recommended " magic number "– minimum is generally 24 panelists, which is sometimes considered rough product screening; 50-100 panelists usually considered adequate

2.4.1.1 TYPE 1: ANALYTICAL TESTS

Analytical tests are used for laboratory evaluation of products in terms of differences or similarities and for identification and quantification of sensory characteristics (Baker et al., 1988:86). The two major classes of analytical tests include discriminative and descriptive (Committee of the IFT Sensory Evaluation Division, 1981). Both imply experienced and/or trained panelists, used as an instrument to assess differences in aspects of food quality (Charley, 1988:5). Potential panelists are screened for selected personal traits, interest and ability to discriminate differences and generate reproducible results. Training further familiarizes the panelists with test procedures and increases their ability to recognize, identify and recall sensory characteristics (Committee of the IFT Sensory Evaluation Division, 1981).

i) ANALYTICAL DISCRIMINATIVE TESTS

The simplest sensory tests merely attempt to answer whether any difference at all exists between two types of products (Lyon et al., 1992:2). These are discrimination tests, or simple difference testing procedures. The discrimination test is a small panel test, used in a laboratory environment. Qualified subjects are used to make reliable and valid decisions, with each subject providing replicate judgements. Using consumers for discrimination tests is not recommended (Sidel, 1988). Analysis is based on frequencies and properties (counting right and wrong answers). From the test results, differences are determined based on the proportions of persons who are able to choose a test product correctly from a set of similar or control products.

There are two types of discriminative tests, including difference tests and sensitivity tests. Difference tests measure whether samples can be differentiated at some predetermined level of statistical probability, e.g. $p < 0.05$. These are often used in industry for reduction of costs associated with processing change, for testing product stability and for quality control (Charley, 1988:6). Sensitivity tests measure the ability of individuals to detect sensory characteristics (Committee of the IFT Sensory Evaluation Division, 1981; Baker et al., 1988:88).

Analytical Discriminating Tests: Difference Tests.

There are several types of difference tests:

* Paired–comparison – this test is used to determine if two samples differ in specific character (Lyon et al., 1992:24). Judges are given two coded samples (Charley, 1988:6).
* Duo–trio test – this test employs three samples, a identified reference sample, followed by two coded test samples (Meilgaard et al., 1991:71). One of the coded samples matches the reference and the other is a variation of the variable under investigation (Lawless and Heymann, 1998:799). The judge choose the test sample that matches the reference, the difference need not be specific (Charley, 1988:6).
* Triangle test – this test employs three coded samples, two identical and one different, presented simultaneously. Choose the sample that is most different (Amerine et al., 1965:122).
* Ranking test – this test is used to make simultaneous comparisons of several samples on the basis of a single characteristic (Committee of the IFT Sensory Evaluation Division, 1981). Samples must be ranked on the same quality (e.g.,

taste, colour, flavour) (Amerine et al., 1965:122) to establish the magnitude of difference between samples (Lyon et al., 1992:24).

* Rating differences / Scalar difference from control – this test may be used when a control sample is available for comparison with one or more experimental sample (Baker et al., 1988:88).

Analytical Discriminating Tests: Sensitivity Tests.

There are two types of sensitivity tests:

* Threshold – usually expressed as absolute, which is the minimum detectable level of concentration of a substance.
* Dilution – the dilution technique determines the smallest amount of best material that can be detected when it is mixed with a standard material. (Committee of the IFT Sensory Evaluation Division, 1981).

ii) ANALYTICAL DESCRIPTIVE TESTS

Descriptive analysis is the sensory method designed to identify and describe the attributes of a food, material, or product using human subjects who have been specifically trained for this purpose and to use these characteristics to quantify differences between products (Charley, 1988:6). This analysis can be limited to certain aspects as in flavour or texture profiling. Proper use of the descriptive analysis method requires that the panel be carefully selected according to their ability to perceive differences between test products and verbalize perceptions. Subjects are screened for their sensory acuity (Sidel et al., 1988) and then special training is required to perform profile and quantitative descriptive analyses and maintained under the supervision of a sensory analysis professional who has extensive experience using this method. Descriptive tests may be used to support or interpret instrumental methods and other sensory tests (Charley, 1988:6).

There are two general types of descriptive tests, as described by Lawless and Heymann, (1998:7) and Baker et al., (1988:88) as attribute rating descriptive tests and descriptive analysis descriptive tests.

Analytical Descriptive Tests: Attribute rating.

There are, in turn, two types of rating tests.

* Category Scaling – structured and unstructured
* Ratio Scaling – magnitude estimation

By rating the sensory characteristics (appearance, odour, flavour, texture and after-taste) the sensory profile of the product will be generated (Lyon et al., 1992:27).

Analytical Descriptive Tests: Descriptive analysis.

There are also several types of descriptive analysis tests, including (Baker et al., 1988:88):

* Flavour Profile Analysis
* Texture Profile Analysis
* Quantitative Descriptive Analysis (QDA)

2.4.1.2 TYPE 2: AFFECTIVE (PREFERENCE AND ACCEPTABILITY) TESTS

The second major class of sensory tests are those called hedonic or affective test methods (Lawless and Heymann, 1998:7). These are tests in which subjective attitudes, such as product acceptance and preference, are measured (Sidel, 1988). An attempt is thus made to quantify the degree of liking or disliking a product (Lawless and Heymann, 1998:628).

Generally, a large number of respondents are required for such evaluations. These panelists are not trained, but are selected at large to represent target or potential target populations (Baker et al., 1988:88). Respondents or panel members are usually consumers who are selected in accordance with a number of criteria (Lawless and Heymann, 1998:470; Sidel et al., 1981), which frequently include:

* previous use or potential users of the product.
* size of family or age of specific family members.
* occupation of head of household.
* economic or social level and
* geographic area.

The most common approach is to offer people a choice of alternative products, then determine whether there is a clear preference (Lawless and Heymann, 1998:43). Preference tests refer to all affective tests based on a measurement of preference, or a measure from which relative preference may be determined, for example, pleasure-displeasure, like–dislike (Committee of the IFT Sensory Evaluation Division, 1981). Preference measurement may include choice of one sample over another, a ranked order of liking, or an expression of opinion on a hedonic (like/dislike) scale. Preference from ranking tests is direct, while preference from hedonic ratings is implied (Committee of the IFT Sensory Evaluation Division, 1981). Preference methods can be used to determine differences in preference, but not differences *per se* to determine that discriminative tests are required.

In affective tests the task is to indicate preference or acceptance by either one of the three types of affective tests (Baker et al., 1988:88):

* Paired–Preference Test – the test subject is requested to express a preference based on the specified attribute.
* Ranking Test – this is an extension of the paired–preference test approach. The amount of liking (or disliking) for individual samples cannot be adequately determined by this method.
* Rating Tests – Scale ratings reflect respondents' perceived intensity of a specified attribute under a given set of conditions.

Various rating scales have been developed and used, including:

* Hedonic Rating Scale – this test is used to measure the level of liking for food products by a population. The samples are rated as to the degree to which they are liked or disliked (Amerine et al., 1965:122). This scale may be applied in testing for preference of acceptance.
* Food Action Rating Scale – this test may be used to measure the level of acceptance of food products by a population. The scale is not applicable for rating specific characteristics; rather it is a measure of general attitude toward a food product (Lawless and Heymann, 1998:466).

Correct application of sensory techniques involves correct matching of methods to the objective of the tests, and this requires good communication between sensory specialists and end-users of the test results. Logical choices of test participants and appropriate statistical analyses form part of the methodology.

Analytic tests require good experimental control and maximization of test precision. Affective tests, on the other hand, require use of representative consumers of the products and test conditions that enable generalization to how products are experienced by consumers in the real world.

2.4.2 MEASUREMENT

The definition of sensory evaluation emphasizes the importance of measurement for treating sensory evaluation as a scientific discipline. Measurement is critical to quantifying responses to sensory stimuli for the purpose of utilizing descriptive and inferential statistics (Stone and Sidel, 1993:66).

2.4.2.1. COMPONENTS OF MEASUREMENT: SCALES

Methods of scaling involve the application of numbers to quantify sensory experience. It is through this process of numberification that sensory evaluation becomes a quantitative science subject to statistical analysis (Lawless and Heymann, 1998:208).

The different types of scales are distinguished on the basis of the ordering and distance properties inherent in measurement rules. According to Lawless and Heymann (1998:208) and Drewnowski and Moskowitz, (1985) the three common methods most often used for scaling in sensory evaluation are:

* Category rating which is perhaps the oldest and most widely used scaling method. Panelists assign numerical values to the perceived sensations based on specific and limited responses. Category scales ranging from 1 – 9 or from 0 – 100 points and anchored at each end with adjectives such as “not at all salty” to “extremely salty”.

* At the other extreme is the method of magnitude estimation, which allows panelists to assign any number they wish to reflect the ratios between sensations.
* The third popular method is that of line marking, where the panelist makes a mark along a line to indicate the strength of sensation or degree of liking.

2.4.2.2. LEVELS OF MEASUREMENT

Measurement theory determines that numbers can be assigned to events in different ways. At least four ways of assigning numbers to events exist in popular usage. According to Lawless and Heymann, (1998:211) these are commonly referred to as:

* Nominal scaling for use in classification or naming (Ordinal scaling for use in ordering or ranking)
* Interval scaling for use in measuring magnitudes, and assuming equal distances between points on the scale and
* Ratio scaling for use in magnitudes, assuming equality of ratios between points.

2.4.3. FOOD ACCEPTABILITY AND PREFERENCE

There are two main approaches to consumer sensory testing: the measurement of preference and the measurement of acceptability (Lawless and Heymann, 1998:430). When using affective tests it should be remembered that acceptability and preference are not the same thing. For example, one sample may be preferred above another sample, but both may be found unacceptable (Lyon et al., 1992:31). The terms "acceptance" and "acceptability" are used to refer to degree of liking and disliking (Lawless and Heymann, 1998:628).

2.4.3.1 ACCEPTABILITY

The Committee of the IFT Sensory Evaluation Division, (1981) define acceptability as:

* an experience or feature of experience, characterized by a positive attitude; and/or
* actual utilization, for example, purchase or eating

Acceptability data are more informative than preference data, since both products may be disliked, and preference itself can often be inferred from acceptability ratings (Lawless and Heymann, 1998:628).

2.4.3.2 PREFERENCE

Preference may be defined as:

* the expression of higher degree of liking, or
* the choice of one object over others and/or

* the psychological continuum of affectivity (pleasantness versus unpleasantness) upon which such choices are based (Committee of the IFT Sensory Evaluation Division, 1981).

Preference of food can be measured directly by affective tests paired comparison or ranking methods, while preference from hedonic ratings is implied (Committee of the IFT Sensory Evaluation Division, 1981).

2.4.4 TECHNIQUES AND SCALES

* Ordinal scales

In ordinal scaling, numbers or words organized from "high" to "low", or "most" to "least" are assigned to recognize the rank order of products with regard to some sensory property, attitude, or opinion (such as preference). In this case, increasing numbers assigned to the products represent increasing amounts or intensities of sensory experience (Lawless and Heymann, 1998:211, 212).

Ordinal scales are considered to be the most basic scales used for measuring perceived intensities, but the numbers do not tell anything about the relative differences among the products. Other than direction, all that is assumed is that a category is either greater or smaller than another category. Thus, one cannot draw conclusions about the degree of difference perceived, nor the ratio or magnitude of difference (Stone and Sidel, 1993:73).

* Ranking tests

Ranking, a form of preference testing with multiple samples, is one of the most commonly used types of ordinal scale. Ranking, the act of ordering a group of products with respect to the perceived intensity of a sensory attribute or the degree of liking, is an alternative to traditional scaling (Lawless and Heymann, 1998:212, 238). By ranking the stimuli in order of merit, an acceptable way of comparing different products is ensured (Drewnowski and Moskowitz, 1985).

A number of procedures have been developed for ranking products (Stone and Sidel, 1983:75). Ranking methods are common in sensory preference work with the advantage of simplicity in instructions to subjects and simplicity in level of measurement, since the data are treated as ordinal (Lawless and Heymann, 1998:212). Three or more coded samples are presented simultaneously.

In these tests the consumer is asked to rank several products in either descending or ascending order of preference or liking. Ranking indicates the direction of the preferences for the product, but beyond ranking, no idea of the relative differences between products are given (Stone and Sidel, 1993:75).

An alternative to the limited information obtained from ranking is provided by the use of rating scales. These scales provide subjects with an unbroken continuum or with ordered categories along a continuum (Stone and Sidel, 1993:75). Rating is a general term for the application of numerical values or numerical response categories to products based on their sensory attributes. The total number of samples tested is dependent upon the subject's span of attention and memory, as well as physiological considerations (Committee of the IFT Sensory Evaluation Division, 1981). Due to its simplicity, ranking may be an appropriate choice in situations where participants would have difficulty understanding scaling instructions. In working with illiterates, young children and across cultural boundaries, ranking is worth considering (Lawless and Heymann, 1998:238).

* Direct rating system: Hedonic Rating Scale

Hedonic, refers to the likes, dislikes, or preferences of a person (Lawless and Heymann, 1998:801). To determine the degree of liking, rating tests are required (Charley, 1988:11). The direct rating system is one of the principal ways of obtaining data on taste hedonics (Drewnowski and Moskowitz, 1985). The Hedonic Rating Scale has achieved wide popularity since it was first compiled in the 1940's at the Food Research Division of the Quartermaster Food and Container Institute in Chicago, Illinois, and is also known as a degree–of–liking scale (Lawless and Heymann, 1998:450). This method makes use of a fully anchored hedonic preference scale, with a centered neutral category point: "neither like nor dislike" (Drewnowski and Moskowitz, 1985) and attempts to produce scale point labels with adverbs that represent psychologically equal steps or changes in hedonic tone. It is a scale with ruler like properties with equal intervals, that enable statistical analysis (Lawless and Heymann, 1998:450).

This test is used to measure the level of liking of food products by the population. It may be applied in testing for preference or acceptance (i.e., preference is inferred from hedonic ratings). This method relies on test subjects' capacities to report, directly and reliably, their feelings of like and dislike (Committee of the IFT Sensory Evaluation Division, 1981).

A Hedonic test involves a sample of 50 to 100 consumers, who are regular users of the product (Committee of the IFT Sensory Evaluation Division, 1981). The test involves alternative versions of the product, conducted in some central location or sensory test facility. The large size of the affective test panel is due to the high variability of individual preferences (Lawless and Heymann, 1998:11).

Several variations of the traditional nine–point hedonic scale have been used effectively. These include:

* a reduced numbers of rating categories (not fewer than five);
* a greater number of "like" rating categories than "dislike";
* omission of the neutral rating category product (Committee of the IFT Sensory Evaluation Division, 1981);
* the use of a non-structured, non-numerical line scale anchored with "like" and "dislike" on the opposite ends;
* the use of the facial hedonic scale (Committee of the IFT Sensory Evaluation Division, 1981; Lawless and Heymann, 1998:221, 455).

The verbal scale may be replaced with other response formats including the facial hedonic scale or an unstructured line scale. Here the ratings are converted to numerical scores so that it can be evaluated statistically (Charley, 1988:11). These facial hedonic scales have been often used in studies using children and those with limited reading skills, but Stone and Sidel (1993:88) discourage the use of these scales due to the limited research information published on their use.

It must be recognized that in addition to sensory variables, important attitudinal and socioeconomic factors are likely to be involved in hedonic ratings. Sensory evaluation must thus aim to develop products that satisfy the consumer' acceptance as well as community health needs (Drewnowski and Moskowitz, 1985).

2.4.5 SENSORY TESTING ENVIROMENT

The sensory facility should be located close to potential judges, but not in the middle of areas with extraneous odours and/or noise. The sensory booth area must be easily accessible to the panelists, and there should be ample, easy parking available. This frequently means that the sensory facility should be on the ground floor of a building and that the area should be near the entrance to the complex (Lawless and Heymann, 1998:85).

*	Evaluation area

The evaluation area may be as simple as a large room with tables or temporary booths placed on tables where as many variables as possible can be controlled (Larmond, 1977:13). The traffic pattern of the panelist should be kept in mind. Panelists should enter and exit the facility without passing through the preparation area. Panelists should have no physical or visual access to the preparation area when samples are being prepared (Lyon et al., 1992:75).

In most cases, a facility is ideally described as a quiet area free from distraction, with controlled lighting, partitions between subjects to minimize visual contact, neutral colours for the walls, and odour-free wherever possible (Campbell et al., 1980:436). Air conditioning, spittoons and comfortable chairs are required. It is especially important that the panelists not influence each other. Panelists should not be allowed to communicate with each other or with the server (Amerine et al., 1965:135). If temporary booths are not available, the tables in the room must be arranged so that the participants do not face each other. In most sensory facilities, the evaluation area should encompass a discussion area, a booth area, a waiting room for the panelists and in some consumer testing facilities, a briefing area may be adjacent to the waiting room (Lawless and Heymann, 1998:86, 87).

Lighting in the booth area is fluorescent, except in the booths themselves, where incandescent lighting is recommended. This lighting should provide sufficient, shadow-free light (Lyon et al., 1992:78). The temperature and relative humidity for the booth and discussion areas should be twenty to 22°C with a humidity between fifty to

55. These conditions make the environment comfortable for the panelists and prevent them from being distracted by the temperature or the humidity (Lawless and Heymann, 1998:90). The room should have a ventilation system that completely removes odourized air and introduces a controllable odour-free background (Lyon et al., 1992:78).

2.4.6 PREPARATION AND SAMPLING

Only food that is prepared by a method that can be duplicated is worth the effort. All serving procedures and sample preparation techniques, except the variable(s) under evaluation, should be very carefully standardized. Only when the conditions are controlled and defined, can differences in quality be attributed to known variables (Campbell et al., 1980:434).

The sensory specialist should pay careful attention to the following areas: the visual appearance of the sample, sample size and shape, and sample serving temperature. There should be decided which serving containers should be used, whether the sample should be served with a carrier, how many samples should be served in a session and whether the panelists should rinse their mouths between samples (Lawless and Heymann, 1998:805).

*   Sample size and appearance

The sample is the product under testing (Lawless and Heymann, 1998:806). If the samples are evaluated by means of a discrimination test and the appearance of the sample is not the variable under evaluation, then the samples should appear as identical and uniform as possible. The only difference should be in the characteristic being evaluated (Larmond, 1977:15). Sample size affects the intensity scores assigned to attributes by panelists, even when the panelists are unaware of the sample size differential (Lawless and Heymann, 1998:92, 93).

A well-mixed homogeneous sample is ideal, but is possible with only a few foods such as fruit juices and mashed potatoes. If canned or frozen foods are being sampled, the contents of several cans or packages should be mixed before sampling. Special care is necessary to obtain reliable results with non homogeneous materials, for example where one muscle is selected from a slice of meat for scoring, or a judge should be given a sample from the same position in each cake or loaf of bread, since these products vary from end to end. Samples should be equally fresh when judged (Campbell et al., 1980:434).

When deciding on the sample size to serve, the following should be kept in mind: The purpose of the study, the amount of the sample that represents a normal mouthful of the specific product, and the number of attributes the panelist has to evaluate.

Campbell et al., (1980:435) indicate that sufficient food is required to provide each judge with at least two bits or sips of each sample. Lawless and Heymann (1998:92) suggest that it is better to error slightly on the side of a more generous portion size than a more stingy one. However, a reasonable balance between cost associated with the product, storage and preparation in relation to the sample size should be maintained.

* Sample serving temperature

It is important that all samples in a series be at the same temperature when judged (Amerine et al., 1965:150). To obtain meaningful results, the food should be tasted at the temperature at which the food is usually eaten. If the usual temperature is very hot or very cold a more moderate temperature is appropriate, since the taste buds are less sensitive at very high or very low temperatures (Larmond, 1977:15). Campbell et al., (1980:435) state that temperatures of not lower than 7°C or higher than 77°C should be used.

Serving temperatures and holding time can present difficulties with some products such as meats. One approach is to serve the items in containers that are themselves warmed. Sand baths heated in an oven to a fixed temperature (usually 50°C) can also be used (Lawless and Heymann, 1998:93). In dairy products such as fluid milk, sensory characteristics may be accentuated if the product is warmed to a temperature above that of storage. When sensitivity and discrimination are the primary concerns, a serving temperature allowing better discrimination is required. Thus, fluid milk can be served at 15°C instead of the more usual 4°C to enhance the perception of volatile flavours. Ice cream should be tempered at –15°C to –13°C for at least 12 hours before serving and it is also best to scoop ice cream directly from the freezer immediately before serving (Lawless and Heymann, 1998:93). Lyon et al., (1992:10) indicate that sensory characteristics of products, especially frozen vegetables, deteriorate more rapidly when stored at frozen temperatures higher than –25 °C to –30°C.

When samples are served at ambient temperatures, the ambient temperature during each session should be measured. For samples served at non ambient temperatures, the serving temperatures should be specified, as well as the method of maintaining that temperature, for example sand baths, thermos flasks, water baths, warming tables, refrigerators, freezers, etc. (Lawless and Heymann, 1998:93).

Lawless and Heymann (1998:93, 94) also indicate that the sample holding time at the specified temperature should also be specified. If samples are held for an extended period, the holding period can lead to changes in the sensory attributes of the product.

* Serving containers

Containers that are most convenient without negatively affecting the sensory attributes of the product should be chosen. Serving containers for all samples in a series should be identical in size, colour and shape (Lyon et al., 1992:79). White or clear containers are preferred so that the colour of the food will show clearly. Glass is used most frequently. Plastic or disposable containers may be used if they do not impart flavour to the sample (Campbell et al., 1980:435).

*   Carriers

The issue of whether or not to use carriers poses some problems and deserves careful consideration. Lawless and Heymann (1998:95) refer to carriers as materials that form a base or vehicle for the food being tested. In food evaluation, a carrier could for example be milk served with a ready-to-eat breakfast cereal or cake served with frosting.

The use of a carrier should be viewed within the context of discrimination tests and its relationship to product consumption in the home. In discrimination testing, the test is not intended to duplicate product use in the home, the goal is often to do a test that will be very sensitive to product differences. In general, carriers tend to dilute and/or mask differences and simply increase the overall complexity of the sensory impressions. In such cases, the use of a carrier might not be desirable (Stone and Sidel, 1993:167; Lawless and Heymann, 1998:95).

The single most persuasive argument advanced by proponents of the use of the carrier is "that is how the product is consumed" (Stone and Sidel, 1993:167). The degree of realism added by the carrier may complicate the situation, but it could prevent the detection of a difference that might be meaningless to consumers. For a food product that is rarely consumed alone and almost always involves a carrier, the "artificiality" of the situation where the carrier is omitted may be a problem. An example is cherry pie fillings which are rarely eaten without pie crust (Lawless and Heymann, 1998:95).

Two guidelines for consideration in determining whether a carrier should be used, are given by Lawless and Heymann (1998:95): the relative consequences of missing a difference versus. a false positive test result, and the degree of realism that is deemed necessary.

* Palate cleansing

The goal of palate cleansers should be to aid in the removal of residual materials from previous samples (Lawless and Heymann, 1998:95, 96). Campbell et al., (1980:437) suggest that each panelist should be provided with a glass of room-temperature water for rinsing between samples.

Unsalted crackers or apple wedges may be used to remove flavours from the mouth. Cold water is avoided because it may dull the sense of taste. Lawless and Heymann (1998:96) also suggest the use of untainted fish as the cleanser to use between test samples.

* Swallowing and expectoration

In most analytical sensory tests, swallowing is avoided and samples are expectorated, to prevent the taste/flavour to be carried over or influence the taste perception from one product to the next. In consumer testing, where acceptability is being measured, swallowing and post ingestion effects can affect consumers' opinions of the product (Lawless and Heymann, 1998:96). However, whether the panelist swallows the sample or not, the panelist must follow the same method with each sample in the test (Larmond, 1977:16).

* Randomization and blind labeling

Samples are best identified by a code rather than a descriptive name. Codes such as A and B or 1 and 2 are undesirable, because the first of a series suggest first choice to the judges (Campbell et al., 1980:435). Samples should be blind labeled with randomly selected letters, three-digital numbers from a table of random numbers (Amerine et al., 1965:125), geometric shapes, colours, or symbols to avoid bias and no two products should be assigned the same code in a test. When one series of samples is to be evaluated several times, judging will be more accurate if the code and order of presentation are altered each time (Campbell et al., 1980:435). Randomizing the order of presentation will help to avoid or minimize psychological errors such as the contrast effect and the time-order error (Stone and Sidel, 1993:101).

The setting-up instructions in Appendix C indicate how sample order may be randomized for rating, ranking and hedonic tests. Appendix D shows a master sheet prepared according to the instructions in Appendix C (Lawless and Heymann, 1998:99, 100 and 102).

*	<u>Number of samples per session</u>

The number of samples that can be judged efficiently in one session is limited. Recommendations for the exact number differ as the type of food, the closeness of the quality level of the foods, the type of test and the objective of the sensory evaluation vary (Amerine <u>et al.</u>, 1965:125).

More samples can be scored in colour or texture evaluation than in flavour evaluation, because the taste and odour senses are more easily fatigued (Lyon <u>et al.</u>, 1992:44). More bland than strong-flavoured samples can be evaluated in one session. Fewer samples can be evaluated when complex score cards are used than when simple scoring systems are used (Lawless and Heymann, 1998:103, 104). The number of questions asked about the sample and the amount of samples the panel need to evaluate also influence the number of samples that can be judged in one session (Lyon <u>et al.</u>, 1992:44).

A general guideline set by Campbell <u>et al.</u>, (1980:436) suggests six single samples or pairs of samples. This constitutes the maximum number that should be presented to a trained panel for evaluation. Inexperienced consumer panels should be given fewer samples.

2.4.7 SELECTION AND TRAINING OF THE PANEL

* Selection of a panel

A panel can be defined as a group of people chosen for specific characteristics such as product usage, sensory acuity, or willingness to participate in repeated sensory tests (Lawless and Heymann, 1998:804). Procedures used to select a panel will depend on the type of sensory testing to be done as well as on the circumstances (Campbell et al., 1980:437).

Selection of panelists requires great care (Amerine et al., 1965:125). Generally, a panelist can be defined as a participant in a sensory evaluation. Several related terms are commonly used. "Panelist" connotes a participant as a member of a group that is often tested on more than one occasion. "Judge" is an older term for a sensory panelist with some special qualifications, such as having been screened for sensory function and possibly trained. "Subjects" is a term for a participant in a psychological experiment, where sensory tests are focused experiments on sensory-product interactions (Lawless and Heymann, 1998:804).

It is important that the people who are recruited know what is expected from them during the study. As much information as possible about time commitment and the product categories should be available to the potential panelists, before they commit to the project (Lawless and Heymann, 1998:110). In many cases, it is important that the judges be available for the entire period of the experiment, be interested in the problem and that they not dislike the food to be tasted (Campbell et al., 1980:437; (Amerine et al., 1965:125). Panelists must also be told clearly what they may expect to gain from the study, such as money (Lawless and Heymann, 1998:110). They can be either male or female, but must be in good health. Judges should be asked to refrain from eating a meal for at least sixty minutes and from smoking, snacking, or chewing gum for twenty minutes before the test session (Campbell et al., 1980:437).

For certain product categories it may be necessary to have the panelists undergo a medical screening prior to participating in the sensory study. Additionally, the sensory specialist may need to screen the sensory acuity of the potential panelists (Lawless and Heymann, 1998:110). For discrimination and descriptive testing, panelists may be selected on the basis of their taste thresholds, not especially for predicting sensitivity to the taste of food, but for the ability to recognize the four basic tastes. The ability to recognize duplicate samples in a triangle test is considered important and is use as a basis for selecting of panelists for these tests (Campbell et al., 1980:437). However, the specialist should allow some leeway in the sensory deficiencies of the potential panelists. Many average potential panelists will improve markedly with training (Lawless and Heymann, 1998:110).

A trained panel should never be used to evaluate the acceptability of a sample, because a trained panel will evaluate the samples objectively, and acceptance in this context is subjective (Lyon et al., 1992:33) (Subjective: Not independently verifiable, as in the expressed likes or dislikes of a specific individual [Lawless and Heymann, 1998:807]). Panelists used for acceptance or preference testing are selected to represent some segment of the population (Campbell et al., 1980:438). Thus, product usage socioeconomic, cultural and geographic factors rather than ability are used as the basis for selection of the panelists (Campbell et al., 1980:438; Stone and Sidel, 1993:168).

* Size of panel

Availability of qualified panelists as well as the inherent variability in the product should influence the size of the panel (Campbell et al., 1980:438). The panel size should be as large as possible in order to reduce the experimental error and to improve the reliability of the results. A minimum of five to ten (Amerine et al., 1965:125) panelists has been suggested for descriptive and discrimination testing, whereas at least fifty to hundred panelists, should be used for acceptance or preference testing with consumer panels (Campbell et al., 1980:438).

* Training the judges

The amount of training required is dependent on the task and the level of sensory acuity desired. In sensory evaluation, subject training is usually limited to descriptive or quality tests that require the respondent to identify or describe a product's sensory characteristics (Sidel, 1988). For most descriptive tests, extensive and in-depth training is necessary. Many discrimination tests require a minimal training (Lawless and Heymann, 1998:112). Training involves presentation of selected stimuli (products and ingredients) over time until the subject's response satisfies some established performance criteria (Sidel, 1988). The intent is to have panelists behave as a calibrated instrument (Charley, 1988:10). Formal training usually begins after screening and the orientation process. Training must ensure panel maintenance which includes the ongoing training and monitoring of performance. This includes review of orientation and training exercises and implementation of new exercises (Campbell et al., 1980:439).

* Choosing a consumer panelist

Unlike the analytic sensory test where some level of sensory function is usually of importance, panelists chosen for acceptability testing are selected on the basis of product usage (Lawless and Heymann, 1998:407). This is the reason why the respondents or panel members are usually consumers (Sidel et al., 1981) who are selected in accordance with a number of criteria.

People may or may not have good sensory function, but panelists for acceptability or preference testing are selected to represent some segment of the population (Campbell et al., 1980:437). Thus, product usage (Lawless and Heymann, 1998:470) economic or socioeconomic level, cultural and geographic factors rather than ability are used as the basis for selection of the judges (Campbell et al., 1980:437). If the panel is not a representative sample of that population, then the data will have little or no predictive value (Lawless and Heymann, 1998:470).

In laboratory situations, consumer demographics are often substituted in favour of accessible respondents (e.g., employees) whose preference and acceptance behaviour satisfactorily correlate with those of the target consumer population. In laboratory–type acceptance tests, the tests can be done with 25 to fifty consumers (Sidel, 1988), but in field studies, generally, a large number of respondents are required and these panelists are not trained, but are rather selected at large to represent target or potential target populations (Baker et al., 1988:88).

2.5. SUMMARY

Dietary guidelines currently being proposed in Western industrialized nations, mainly focus on recommendations for prevention of chronic diseases. Recommendations to reduce salt intake to combat or delay the development of hypertension and age related increases in blood pressure, form an essential component of these dietary guidelines.

Although hypertension cannot be linked to a certain segment of the population, the Black population, the male gender and the elderly, have enhanced susceptibility to hypertension. In spite of this, studies indicate that even among youths, lowered sodium intake is proposed in the hope that it may decrease the risk of hypertensive disease later in life.

Since few diets lack sodium, the general public's gross consumption of sodium, reflect an acquired taste for salt and show evidence of a tendency towards salt-seeking behavour. Consumption data support this high salt intake from food and indicate that food preparation and the use of commercially prepared foods are the areas in which sodium levels can be altered to reduce sodium intake.

Individuals following salt restricted diets have difficulty in complying with the diet, because sodium restricted diets are considered bland and tasteless. Thus, a study investigating the acceptability of home-prepared products low in sodium was considered necessary, in order to make recommendations that can improve the compliance of patients requiring sodium-restriction.

Although little is really known about the reason for the preference for salty foods, the first step in reducing salt intake is to understand sensory responses to salt. These sensory responses include taste adaptation to a certain sodium concentration, sodium interaction with other food components, the inhibitory or masking interaction in mixtures of different tastes, as well as developmental studies of salt taste perception in children and the elderly.

CHAPTER 3

EXPERIMENTAL PROCEDURE

3.1. INTRODUCTION

For the purpose of this study the following framework (Figure 3.1) was compiled to describe the experimental procedures for the evaluation of home-prepared foods lower in sodium.

Because of the effects of the nutrition transition on dietary patterns, the increase in the prevalence of hypertension and the "salt seeking" behaviour of most people, a need for foods lower in sodium was identified within a specific target market. The test methods and food items which were evaluated were determined according to a representative sample of the target market.

During sensory evaluation a questionnaire (Appendix E) was completed and used to determine the panel composition (age group and ethnic group). The relationship between acceptability, salt perception and the demographic variables (age and user type) were determined statistically.

Affective tests were used to evaluate acceptability and salt perception of the different sodium levels (normal sodium level, approximately one third sodium reduction and approximately two third sodium reduction) by means of sensory evaluation.

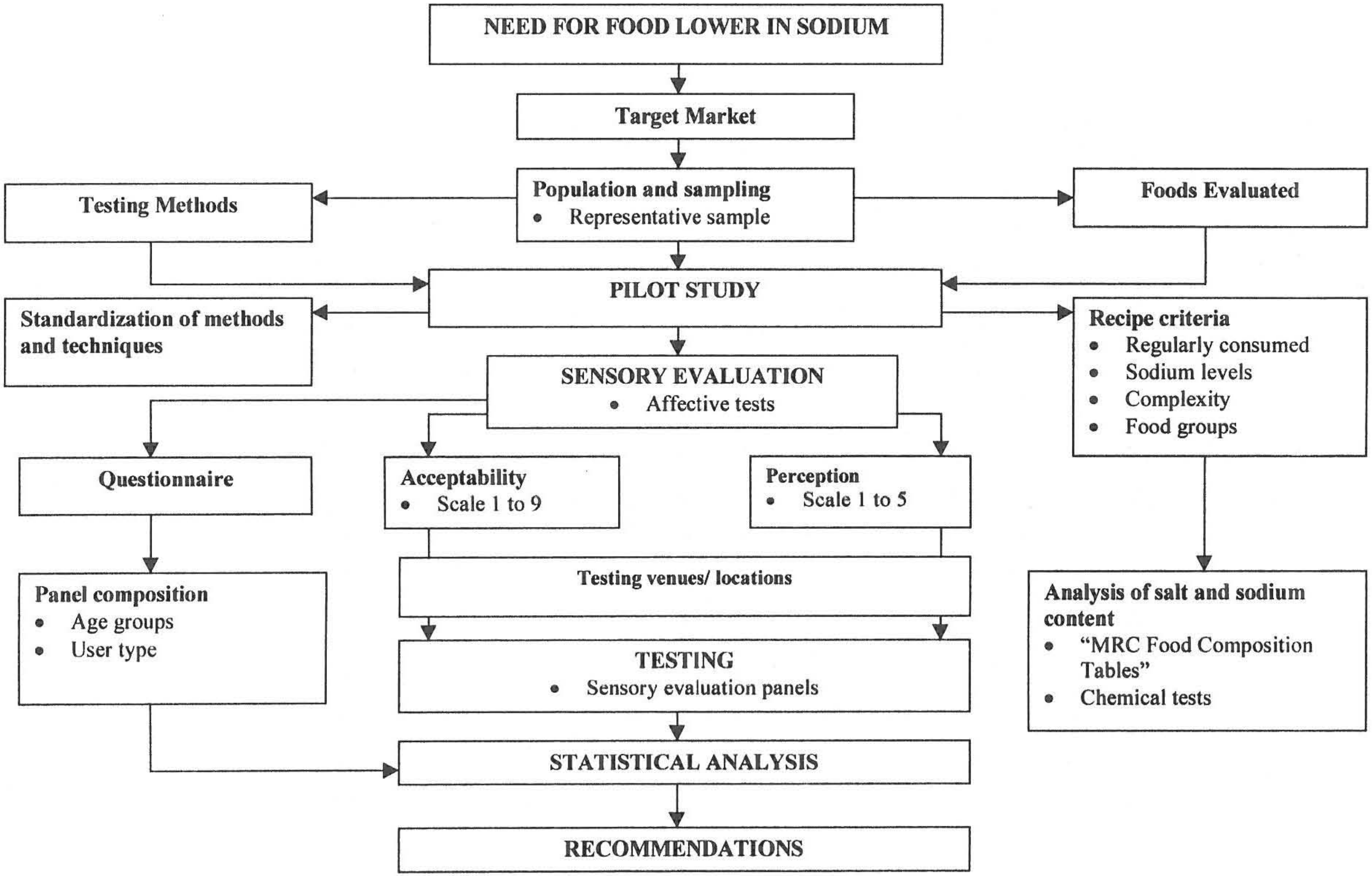


Figure 3.1. Framework of the experimental procedures for the study

3.2 PILOT STUDY

Ten consumers took part in the pilot study. During the pilot study recipe criteria were determined, recipes were tested and the testing procedures were standardized. All handling procedures, preliminary preparations and serving procedures as well the heating temperatures and holding times were standardized.

The pilot study served to determine the following:

* Standard preparation apparatus necessary.
* Suitable containers for serving the specific dishes.
* Coding of samples in order to eliminate any assumptions in respect of the most suitable sample.
* Suitability of questionnaires and evaluation forms.

The information gathered by means of the pilot study, also indicated how many panel members could comfortably be handled during an evaluation session and indicated the necessity of additional help during evaluation sessions with poorly literate panel members.

3.3 POPULATION AND SAMPLING

The target market was the general consumer, because a moderate consumption of salt or a reduction in the habitual use of salt as a dietary prescription is directed at the general public. Regular use/consumption of the dishes presented in this study and the geographic area were the criteria according to which the consumers were selected for inclusion as panel members.

For the evaluation of the preference and acceptability of the products, affective tests are suggested in order that the consumer can form part of an untrained sensory evaluation panel.

Urbanized White and Black subjects were included, with age and race as precursors. The sampling draw attempted to reflect a representative sample of the White- and Black populations of the Free State. The researcher made use of key persons (Technikon staff and Correctional staff) and posters to approach consumers, who conform to the inclusion criteria, to participate in the study.

* Inclusion/exclusion criteria
    * Persons had to be regular users of the dishes tested, vegetarians were thus excluded.
    * Untrained consumers were used for the panel, so that their reaction to the product could be direct and based on the integral pattern of the sensory stimulus of the product.

* Persons had to comprise part of the target market, so that they could evaluate the products from a particular frame of reference.
* Persons had been available for the full duration of both panels (acceptability and perception), as well as for the repetition sessions.
* The sample had to include both genders, from different race groups (White and Black) and age groups, in good health.
* Only members who had not eaten, drank or smoked, or nibbled at food, for 60 minutes before the commencement of the evaluation session, and who had not chewed chewing gum for 20 minutes before the commencement, were included.
* Evaluation lists and questionnaires which were not properly completed, or in respect of which the panel member did not turn up for the second session or the repetition session, were omitted.
* Persons who follow a set diet or eat daily at an institution which follows a cycle menu were omitted because taste adaption could have taken place.

3.4 PANEL COMPOSITION

Untrained consumers were included in the evaluation panel. Between fifty to one hundred panel members are considered sufficient for affective tests (Committee of the IFT sensory Evaluation Division, 1981). The consumer sensory panel consisted of sixty consumers (urbanized White and Black persons), from three age groups (table 3.1), who evaluated home-prepared dishes in three sodium levels, according to salt perception and acceptability. The number of panel members was chosen taking available funds for the project into consideration and the ethnic distribution represents that of the Free State Province (Statistics South Africa, report no 1: 03-01-11).

Table 3.1. Panel composition

PANEL MEMBERS	AGE GROUPS	GENDER	PANEL MEMBERS PER ETHNIC GROUPS
Sixty consumers		N = 30 (male) N = 30 (female)	N = 9 (white) N = 51 (black)
	Group 1: Age 17 to 30	Male: 13 Female: 13	White: 4 Black: 22
	Group 2: Age 31 to 50	Male: 11 Female:10	White: 3 Black: 18
	Group 3: Age 50 +	Male: 6 Female: 7	White: 2 Black: 11

Panel members consisted of consumers who volunteered to participate in the study and who conformed to inclusion criteria.

3.5 TESTING VENUES

The facilities of the Hotel School (Technikon Free State) and the Correctional Services, Kroonstad, were used as testing venues.

These facilities were chosen because they comply with the requirements set by Lawless and Heymann, (1998), namely reasonably centrally located, easily accessible for personnel with sufficient parking near test venues. Both the kitchens have standardized apparatus and equipment that facilitates the preparation, serving and keeping of the warm food. The kitchens are also situated in such a way that panel members can enter the evaluation areas without having to move through the preparation area.

At the Hotel School the entertainment lounge was prepared for the evaluation sessions. The entertainment area is fitted with controlled lighting and air conditioning and is sufficiently roomy to allow the tables to be arranged in such a way to allow panel members to evaluate the dishes without being disturbed. Because the entertainment area is provided with an overhead projector and screen, an additional briefing area was unnecessary.

At the Correctional Services, the dining hall was used as the evaluation area and although the kitchen opens directly into the dining hall, it is well ventilated and only that part furthest from the kitchen was used for evaluation to ensure an odour-free evaluation area.

Because the Hotel School is centrally located for students, the main group included in the evaluation sessions at the Hotel School consisted of students, which also form part of age group one (17 to 31).

Panel members needed for age group 3 (50^{+}), were mainly made up of terrain workers and security personnel of the Correctional Services and Technikon. This was also the group that was mostly illiterate and was thus divided into smaller groups per session, to ensure easy facilitation of the evaluation and to improve the validity of the results obtained.

3.6 PREPARATION AND SAMPLING

All the dishes were prepared according to the methods that were standardized during the pilot study. Standard apparatus was used and the person who prepared the dishes (the researcher) was the same throughout.

3.6.1. SAMPLE SIZE AND APPEARANCE

Because visual appearance was not a variable, it was attempted to serve identical samples. The dishes included in this study made it possible to serve well-mixed homogeneous samples of every dish for evaluation. Because a consumer panel was used, only thirty gram of every sample was served.

3.6.2 SAMPLE SERVING TEMPERATURE

According to Amerine et al., (1965:126), dishes must be tasted/evaluated at the temperatures they would normally be consumed. The samples were therefore served at normal serving temperatures as standardized during the pilot study (Table 3.6). Warming trolleys with regulatable thermometers and Bain-maries were used to keep dishes warm.

3.6.3. SERVING CONTAINERS

Disposable plastic containers suitable for the serving of every type of dish were used.

3.6.4. CARRIERS

In the evaluation of porridge, milk was used as carrier, mainly because this is the way in which most consumers eat their porridge at home. No sugar was added.

3.6.5 PALATE CLEANSING

As suggested by Campbell et al., (1980:437), every panel member was provided with a glass of water (room temperature) for the cleansing of the palate after every sample was tasted.

3.6.6 SWALLOWING AND EXPECTORATION

Lawless and Heymann (1998:96) indicate that swallowing the samples is acceptable for consumer testing, because the natural consumption is one of the concerns during consumer sensory evaluation. Although every panel member was provided with a spittoon, very few used it.

To prevent the unwanted influence of one sample on the next, sample sizes were small enough to prevent panelists from fatigue. Flavour carryover was minimized by the instruction on the evaluation forms that prevents re-evaluation of samples after the

3.8 OPERATIONAL DEFINITIONS

For the purpose of the study operational terms are defined as follows:

3.8.1 ACCEPTABILITY

According to Baker et al, (1998:88) acceptability can be defined as "a positive attitude after the tasting experience."

The most common, most efficient and probably the most reliable way to asses positive attitudes towards food or the acceptability of food is to measure the verbally expressed affective responses of a sample of consumers by means of hedonics. Hedonics refers to the likes, dislikes or preferences of a person (Lawless and Heymann, 1998: 801).

Thus, for the purpose of this study, descriptive words were used as hedonic scale anchors to reflect the individual's sensory experiences about the tasting experience. Table 3.2 indicates the descriptive words used to assess like and dislike.

Table 3.2. Descriptive words to define general acceptability (Lawless and Heymann, 1998:12)

like extremely
like very much
like moderately
like slightly
neither like nor dislike
dislike slightly
dislike moderately
dislike very much
dislike extremely

3.8.2. PREFERENCE

The term "preference" refers to and includes a choice among products, a ranked or liking, or an expression of opinion on a hedonic basis (Committee of the IFT sensory Evaluation Division, 1981).

For the evaluation of the panel's perception of the saltiness of the samples/dishes, preference terms were chosen. These terms are based on a saltiness frame of reference that is internal to the dishes used.

Table 3.3. Descriptive words to define salt perception

Tasteless (not salty at all)
Salty, but not unpalatable
Salty, no need for additional salt
Very salty
Too salty, no longer tasty.

3.8.3. DISH COMPLEXITY

Dish complexity was based on the number of main ingredients per dish (Simone et al., 1995) and was divided into two groups, namely simple and complex.

* Simple dishes

Dishes were categorized as simple when containing between one or two main ingredients. For this study mashed potatoes and porridge were included as simple dishes. Main ingredient was defined as the ingredient essential/vital to prepare the specific dish (most often included in the dish name). An ingredient-group (consisting of foods from the same food group, such as vegetables) which represents more than forty percent of the total ingredients included was classified as more than two main ingredients, because of the flavour complexity that the various foods in an ingredient group represent (table 3.4).

Table 3.4. Number of ingredients per simple dish

DISH	NUMBER OF INGREDIENTS	MAIN INGREDIENT
Mashed potatoes	• 5	• Potatoes 83 % of ingredient total
Porridge	• 2	• Maize meal 98 % of ingredient total

* <u>Complex dishes</u>

For this study dishes were categorized as complex, when containing two or more than two main ingredients, or ingredient-groups. Vegetable soup and beef stew were used in this study to represent complex dishes (table 3.5).

Table 3.5. Number of ingredients per complex dish

DISH	NUMBER OF INGREDIENTS	MAIN INGREDIENT
Vegetable soup	• 10	• Vegetables 90 % of ingredient total
Beef stew	• 10	• Meat 57 % of ingredient total • Vegetables 42 % of ingredient total

3.8.4 DISH TEXTURE

Texture is defined as the "characteristic of a product perceived by the visual or tactile senses including geometric qualities, surface attributes, perceived changes under deforming forces and residual tactile sensations following chewing, swallowing, and expectoration" (Lawless and Heymann, 1998:808).

For the purpose of this study the dish texture was defined by using the terms "smooth and coarse", chosen from the word anchors commonly used during descriptive analysis of textural attributes. These terms are usually classified under geometrical characteristics, namely particle shape and size (Stone and Sidle, 1993:214).

According to Lawless and Heymann (1998:386), surface texture, for example roughness, can be assessed both visually and orally. Thus, for the purpose of this study the dish texture was assessed visually and divided into two groups; dishes with smooth texture and dishes with rough (coarse) texture.

3.9. MATERIALS AND METHODS

The following materials and methods were used for the study:

3.9.1. DEMOGRAPHIC QUESTIONNAIRE

The demographic composition of the consumer panel was determined by means of a questionnaire (Appendix E).

The questionnaire was completed by the panel members themselves and included the following information:

* Identifiable details of the panel members (age group, gender and race) as well as questions to determine the following:
* If food is prepared by the panel member him/herself.
* If salt is used during food preparation
* If salt is used at the table and
* what the panel members' own perception of his/her own salt intake is (user type).

3.9.2 SENSORY TESTING METHODS

Sensory evaluation was undertaken according to accepted procedures as described by Lawless and Heymann, (1998:7, 122) and Stone and Sidel, (1993:75). The evaluation schedule was largely determined by the availability of the panel members and evaluation venues.

Affective (acceptability and preference) tests were used in order that the panel members could evaluate every sample according to general acceptability (Appendix F) and perception of saltiness (Appendix G).

3.9.2.1. ACCEPTABILITY

An evaluation form with a nine-point rating scale was used to determine acceptability of the various dishes (Appendix F).

This nine-point hedonic scale is a simple and easy, reliable and stable testing method, that makes provision for a balanced scale of preference with a central neutral category, as well as scale points representing equal psychological changes in the hedonic scale.

Appendix E represents the hedonic scale used. The scale defines the psychological state of "like" and "dislike" on a linear scale with like at the upper and dislike at the lower end of the scale. In accordance with Stone and Sidle, (1993:85), for each hedonic description along the nine-point scale, a numerical value ranging from 9 (dislike extremely) to 1 (like extremely) was assigned on the assumption that a continuum of psychological scale defines directly the physical categories of response. The descriptive words or phrases that are anchors on the scale, reflect the individual's sensory experiences about the stimuli under given set conditions.

The members of the consumer panel used this test method to evaluate the various variations of the dishes by indicating what term best described his/her attitude towards the product. In this way the degree of preference or dislike of a specific product could be determined.

3.9.2.2. PERCEPTION

For the evaluation of the panel's perception of the saltiness of the samples, a numerical ranking scale was used. An evaluation form in conjunction with a line scale ranging from one to five was used, where 1 = tasteless (not salty at all); 2 = salty but unpalatable; up to 5 = too salty, no longer tasty (Appendix G).

The scale enabled the panel to indicate the degree of salt perception of every sample on the line-scale from one to five. Perception or the correlation of sensory impressions determines whether food will be accepted or rejected (Caul, 1977:7). The serving order was randomized and the test method consisted of a forced-choice test. No adaptation of the test method or the evaluation form was necessary for the evaluation of the different dishes.

3.9.3. FOODS EVALUATED

Recipe choices were based on the following:

* Inclusion of dishes regularly consumed by the target market.
* Inclusion of both simple and complex dishes, based on the number of ingredients per dish.
* Recipes suited to adaptation in respect of sodium content.
* Recipes representative of different textures and food groups.

The dishes to be evaluated included:

Simple dishes (based on the number of ingredients per dish), divided into:

* Dishes with smooth texture, i.e. Mashed potatoes (Appendix H).
* Dishes with coarse texture, i.e. Porridge (Krummel pap) (Appendix I).

Complex dishes (based on the number of ingredients per dish), divided into:

* Dishes with smooth texture, i.e. Vegetable soup (Appendix J).
* Dishes with coarse texture, i.e. Beef stew (Appendix K).

Each dish was prepared in three sodium variations:

* The ordinary recipe with the normal sodium content
* Approximately one-third reduction in sodium content.
* Approximately two-thirds reduction in sodium content.

3.10. ANALYSIS OF SODIUM AND SALT CONTENT

Sodium content was estimated using the "MRC Food Composition Tables" and validated using the same chemical tests used by the MRC to determine the sodium content for the composition tables.

3.10.1. COMPOSITION TABLES

The sodium content of every ingredient, except for red meat, was estimated with the use of the "MRC Food Composition Tables" (Langenhoven et al., 1991), which indicate the sodium per 100 gram of ingredient. The sodium content of the red meat was estimated with the use of the tables compiled by the Red Meat Board (Schönfieldt and Welgemoed, 1996:52), which indicate the sodium per 100 gram of ingredient for South African red meat. The values for red meat published in the MRC Food Composition Tables indicate the sodium content of meat in America.

Ingredients were weighed on an analytical scale to determine the exact weight. It was attempted to reduce the sodium content of the dishes only by reducing or omitting the salt added to the recipe. Non of the other ingredients were reduced or omitted. No additional flavourings, herbs or spices, were added to enhance the flavour. In certain dishes ingredients were substituted with a similar "salt-free" variety, that is easily and freely available. To reduce the sodium content of the Mashed potatoes and Vegetable soup with approximately two thirds, it was necessary to substitute the butter with salt free butter. This enabled an approximately two third sodium reduction as well as the use of the original amount of butter, as indicated on the recipe (Appendix H and J), without any sensorical changes in the dishes.

3.10.2 CHEMICAL ANALYSIS

The following test method was followed to determine the salt content of the dishes:

* Principle:

The organic material in the dishes is broken down by cooking it in the presence of Potassium permanganate and nitric acid. The salt content in food is determined by determining the chloride ion concentration with $AgNO_3$. Various ions can be determined with the use of an $AgNO_3$ solution: Cl^-; Br^-; I^-; S^{2-}; PO_4^{2}; SCN. The excess $AgNO_3$ is then titrated with a Potassium tiocyanate solution.

$$AgNO_3 + NaCl \longrightarrow AgCl(\downarrow) + NaNO_3$$

* Reagents used:

Silver nitrate ($AgNO_3$) 0,1 N

Potassiumtiocyanate 0,1 N

Ammoniumiron (iii) Sulphate indicator, saturated solution

Hydrogen nitrate (HNO_3) 66.9–71.6%

Oxalic acid or glucose

Iodized water

* Apparatus used:

Burette (25ml)

Volumetric pipette

Vapour box (damp kas)

Heating mantle (verhittings mantel)

Erlenmeyer flask

* Method used:

Each sample was liquidized and a ± 2g sample was weighed and immediately put in a 250ml Erlenmeyer flask. Precisely 25ml (volumetric pipette) $AgNO_3$ was added as well as 25ml of the HNO_3. It was heated to boiling point (in vapour box) and 10ml potassium permanganate added while the mixture gently boiled. More potassium permanganate was added as soon as the mixture began to lose colour. Usually 5-10 ml was sufficient. A brown colour indicates an excess of potassium permanganate which also indicates that all the organic material has been consumed. It was removed from the heating mantle and by using a small amount of oxalic acid or glucose, the excess potassium permanganate was removed. One hundred ml cold H_2O and 2 ml of the ammonium iron (III) sulfide indicator was added and mixed thoroughly. The sample was immediately titrated. The excess $AgNO_3$ was titrated with the potassium cyanate solution to a light brown colour. Duplicate determinations for all samples were done. A blanco in which the dish sample was replaced with 2 ml water was also done in duplicate.

* Calculations done:

$$\% \text{ NaCl} = \frac{(\text{Titration vol. Blanco - Titration vol. sample}) \times (\text{potassium tiocyanate} \times 5{,}85)}{\text{mass of dish sample weighed}}$$

$$= \frac{(\text{Vol. AgnO}_3) \times 0{,}1 \times 5{,}85}{x \text{ gram food}}$$

3.11. TEST PROCEDURES

Figure 3.2 shows that two dishes, both served in terms of the three sodium variations, were evaluated per evaluation session. Between the evaluation of each dish, there was a fifteen to twenty minute break. During the break the evaluation area was cleaned and all glasses were filled. Each dish and sodium variation were evaluated for both acceptability and salt perception by a consumer panel comprising between ten and twenty-five panel members per evaluation session. Sessions where the panelists were mostly illiterate, consisted of not more than six panelists. The dishes were prepared and heated to the fixed/prescribed temperature (Table 3.6).

Table 3.6 Serving temperature.

FOOD ITEM	SERVING TEMPERATURE
• Porridge	• between 50 – 55°C
• Mashed potatoes	• between 60 – 65°C
• Beef stew	• between 67 – 71°C
• Vegetable soup	• between 61 – 64°C

The evaluation sessions were scheduled for the late morning and the mid-afternoon, as recommended by Larmond (1977:14) as the best time for testing. Samples of the dishes to be evaluated were presented to the panelists on white trays. Samples, each being sufficient for two mouthfuls (± 30g) were served at serving temperature (Table 3.6).

The original and the reformulated sodium variations were coded with three digital codes and served to panelists simultaneously. The order of serving was randomized so that each sample was served in each position an equal number of times.

The evaluation forms and questionnaires were available in Afrikaans and English. Both evaluation forms (salt perception and acceptability) were completed by the panelists during each evaluation session.

In order to ensure the validity and reliability of the evaluations, each sample was evaluated twice with a five to ten minute rest period in-between. During evaluation-session days, both panels evaluated the same types of dishes per day. Panelists participated in no more than one session per day.

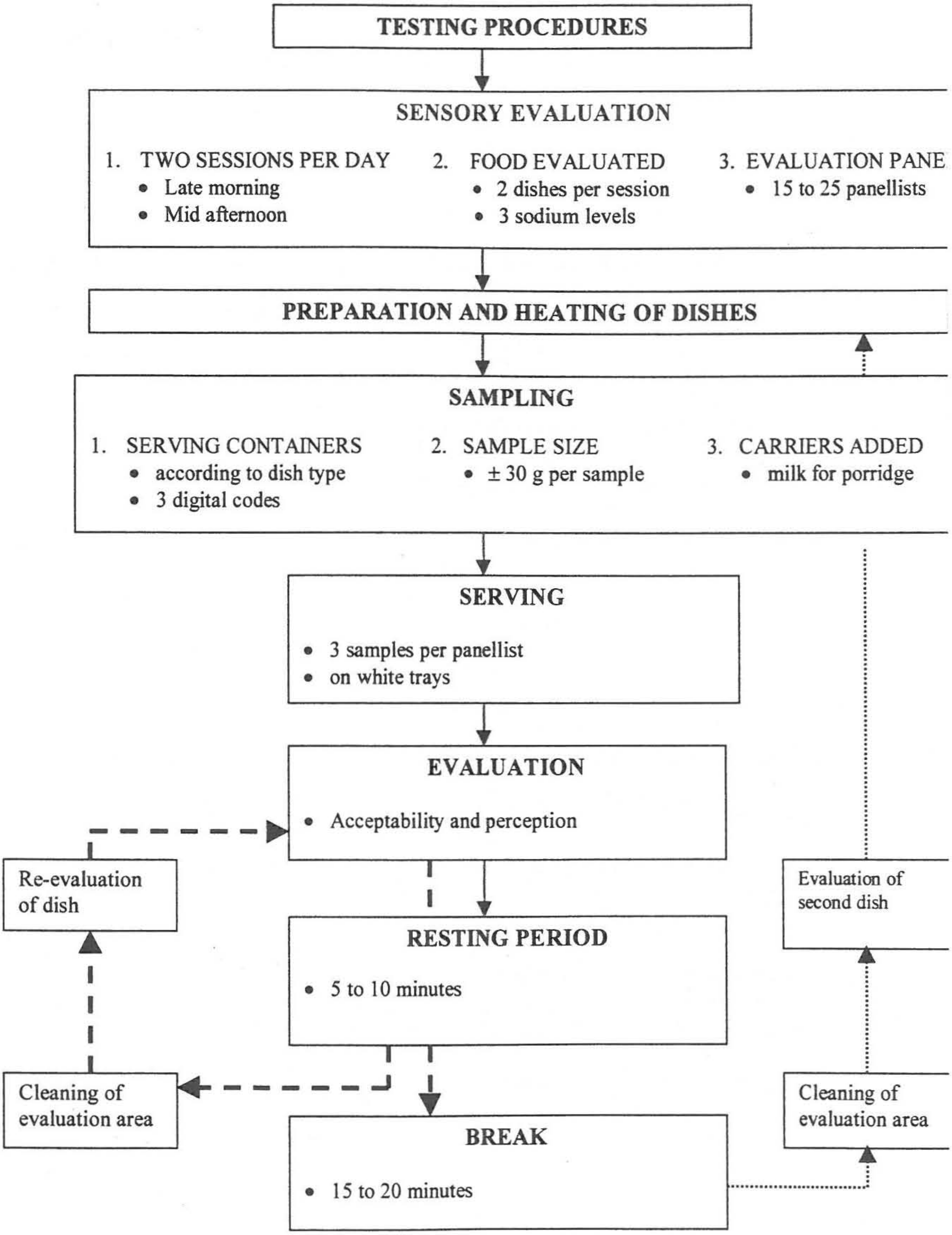


Figure 3.2. Procedure followed for sensory evaluation.

3.12. TIME SCHEDULE

Table 3.7 summarizes the evaluation sessions that took place at the Correctional Services. The panels principally consisted of persons from other areas (Sasolburg, Betlehem, Bloemfontein en Groot vlei), admitted for short-term training in order that a larger representation from the Free State could be obtained. Groups admitted for long-term training and personnel who regularly ate in the dining hall were not included because cycle menus were used and taste adaptation to standardized recipes could have taken place.

The same two dishes were evaluated per day, per evaluation session (on day one just the complex dish in two different textures were evaluated and on day two the simple dish in two different textures). Each age group was divided into sub-groups ([a], [b] and [c]) to ensure that every panel member evaluated all the different dishes.

During the planning of the time schedule for all evaluation sessions it was planned to include 25 consumers per evaluation session. During implementation, however, all the panel members that had been approached to participate in the specific sessions did not arrive. This explains why the total number of consumers per session varies.

Furthermore, the evaluation forms and questionnaires of consumers that participated in the first evaluation session, but not in the second session (to evaluate the second dish combination) were replaced by a consumer that was able to attend both sessions. The days on which evaluations took place thus had to be increased to ensure that 60 consumers (age and ethnic group as indicated in table 3.1) that evaluated dishes twice were included. In total there are thus 66 consumers in the age group 17 to 30 that participated in evaluation sessions, but only 26 of those attended both sessions, evaluated all the dishes and could be included.

Table 3.7. Evaluation sessions at the Correctional Services

DAY	EVALUATION SESSION	NUMBER OF CONSUMERS	COMPOSITION OF PANEL	FOOD EVALUATED
Day one	Late morning	▪ 17	Age group: 31-50 ▪ 15 consumers (a) Age group: 50+ ▪ 2 consumers (b)	Dish one: ▪ Complex dish with coarse texture Dish two: ▪ Complex dish with smooth texture
	Mid-afternoon	▪ 25	Age group: 17-30 ▪ 25 consumers (c)	Dish one: ▪ Complex dish with coarse texture Dish two: ▪ Complex dish with smooth texture
Day two	Late morning	▪ 14	Age group: 31-50 ▪ 12 consumers (a) Age group: 50+ ▪ 2 consumers (b)	Dish one: ▪ Simple dish with coarse texture Dish two: ▪ Simple dish with smooth texture
	Mid-afternoon	▪ 14	Age group: 17-30 ▪ 14 consumers (c)	Dish one: ▪ Simple dish with coarse texture Dish two: ▪ Simple dish with smooth texture

Table 3.8 summarizes the evaluation sessions which took place at the Hotel School.

Table 3.8. Evaluation sessions at the Hotel School

DAY	EVALUATION SESSION	NUMBER OF CONSUMERS	COMPOSITION OF PANEL	FOOD EVALUATED
Day one	Late morning	▪ 18	Age group: 17-30 ▪ 12 consumers (a) Age group: 31-50 ▪ 6 consumers (b)	Dish one: ▪ Complex dish with coarse texture Dish two: ▪ Complex dish with smooth texture
	Mid-afternoon	▪ 10	Age group: 17-30 ▪ 3 consumers (c) Age group: 31-50 ▪ 7 consumers (d)	Dish one: ▪ Complex dish with coarse texture Dish two: ▪ Complex dish with smooth texture
Day two	Late morning	▪ 13	Age group: 17-30 ▪ 9 consumers (a) Age group: 31-50 ▪ 4 consumers (b)	Dish one: ▪ Simple dish with coarse texture Dish two: ▪ Simple dish with smooth texture
	Mid-afternoon	▪ 9	Age group: 17-30 ▪ 3 consumers (c) Age group: 31-50 ▪ 5 consumers (d)	Dish one: ▪ Simple dish with coarse texture Dish two: ▪ Simple dish with smooth texture

Table 3.8. Evaluation sessions at the Hotel School (Continued)

DAY	EVALUATION SESSION	NUMBER OF CONSUMERS	COMPOSITION OF PANEL	FOOD EVALUATED
Day three	Late morning	• 6	Age group: 50+ ▪ 6 consumers (e)	Dish one: ▪ Complex dish with coarse texture Dish two: ▪ Complex dish with smooth texture
	Mid-afternoon	• 6	Age group: 50+ ▪ 6 consumers (f)	Dish one: ▪ Complex dish with coarse texture Dish two: ▪ Complex dish with smooth texture
Day four	Late morning	• 6	Age group: 50+ ▪ 6 consumers (f)	Dish one: ▪ Simple dish with coarse texture Dish two: ▪ Simple dish with smooth texture
	Mid-afternoon	• 5	Age group: 50+ ▪ 5 consumers (e)	Dish one: ▪ Simple dish with coarse texture Dish two: ▪ Simple dish with smooth texture

Because the Hotel School is located centrally on campus, the panels principally consisted of Technikon students, who mainly represent the younger group (17 to 30 years). For the age group 30 to 50 and 50^{-}, Technikon staff members were mainly used.

The same two dishes were evaluated per day, per evaluation session (on day one, just the complex dish in two different textures were evaluated and on day two the simple dish in two different textures). The age groups were divided into sub-groups ([a], [b]; [c]; [d]; [e] and [f]) to ensure that every panel member evaluated all of the different dishes.

3.13. STATISTICAL ANALYSES PERFORMED

The following statistical analyses were performed on the data gather by means of the evaluation forms (acceptability and perception) and questionnaires.

3.13.1 VARIABLES AND FACTORS

Analyses were performed with regards to two variables: acceptability (scale ranging from1 to 9) and salt perception (scale ranging from 1 to 5).

The three main factors were:

* Sodium level ([A] normal sodium in recipe, [B] one-third sodium reduction and [C] two-third sodium reduction).
* Texture (smooth and coarse).
* Complexity with regard to the number of ingredients (simple and complex dishes).

*   Drop-out

Of the sixty consumers included in the sensory evaluation sessions, the information of two panelists had to be excluded from the statistical analysis (one panelist in age group 31 to 50 and one in age group 50^{+}), because the evaluation forms were not properly completed.

3.13.2 RELIABILITY

Of all the consumers taking part in the evaluation panels, only fifty-eight subjects had attended both evaluation sessions and have completed both the evaluation forms and questionnaire properly. The data of these fifty-eight subjects was analyzed and two analyses were made on each subject.

The correlations between the two repeated observations per person with regard to salt perception and acceptability were highly significant, therefore we used the mean of the two in all further analyses. Although we realize that this approach reduces the variability to a slight extent, the correlation between the pairs was so high what we concluded that this aspect was negligible.

Normal probability plots for each level combination did not necessitate the transformation of the observed data on the scale.

The homoscedastic assumption (homogeneity of variances) was also investigated and there was no cause for concern (at a 95 percent significance level).

3.13.3 ANALYSES

The same fifty-eight subjects were used at each of the twelve level combinations (two different textures, two dish complexities and three sodium levels). This prohibited the use of the standard three way factor Analysis of Variance (ANOVA) and necessitated a three way repeated measures/factors Analysis of Variance (ANOVA), which was performed with the aid of both BMDP and SAS packages. Paired difference tests were applied to determine the significance of differences.

A similar premise led to the appropriate use of paired-difference tests also when breaking down the analyses with regard to different age groups and with respect to different salt user types.

3.14 SUMMARY

The effect of the nutrition transition, including the increase in the prevalence of hypertension and the "salt-seeking" behaviour of most people, has triggered the need for foods lower in sodium.

A sample (N = 58) representative of the White and Black population of the Free State was selected for the study.

Sensory evaluation methods were used to assess the difference in salt perception and acceptability of food over three ranges of sodium concentrations (full recipe; approximately one third and approximately two third sodium reduction). Sodium content was estimated using the "MRC Food Composition Tables" and the "Nutritional content of age A (13% fat) beef carcase tables". Sodium content was validated using chemical analysis.

The evaluation panel schedule was largely determined by the availability of panel members and evaluation venues (facilities of the Hotel School and the Correctional Services). Affective (preference and acceptance) sensory tests were applied to measure salt perception and acceptability of four dishes varying in terms of sodium concentration, texture and complexity. Salt perception was rated using a numerical ranking line scale, and acceptability was evaluated according to a nine-point Hedonic scale. Every sample was evaluated twice and the results showed a significant correlation. Samples were coded by means of three digital codes, in order to eliminate any assumption in respect of the order of the samples represented.

Because the same subjects were used at each of the twelve level combinations, it precluded the use of the standard three-way factor ANOVA and necessitated a three-way repeated measured ANOVA, which was performed with the aid of both BMDP and SAS packages. Paired difference t-tests were applied to determine the significance of differences.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

The results obtained from the demographic questionnaire, sodium content of dishes according to the composition tables and chemical analysis, as well as the statistical analyses performed for acceptability and perception of sodium levels, different age groups and user types are presented in this chapter.

4.2. DEMOGRAPHIC INFORMATION OF THE CONSUMER PANEL

Table 4.1 Demographic information of the consumer panel

CATEGORY		N = 58	%
AGE	1. 17 – 30 2. 31 – 50 3. 50 $^{+}$	• 26 • 20 • 12	• 44.83 • 34.48 • 20.69
ETHNIC	1. White 2. Black	• 8 • 50	• 13.79 • 86.21
PREPARE OWN FOOD	1. Yes 2. No	• 34 • 24	• 58.62 • 41.38
SALT ADDED DURING FOOD PREPARATION	According to recipe More than recipe Less then recipe Add no salt	• 23 • 6 • 4 • 1	• 67.65 • 17.65 • 11.76 • 2.94

Table 4.1 Demographic information of the consumer panel (Continued).

CATEGORY		N = 58	%
SALT ADDED AT TABLE	1. No salt 2. Habitually, before tasting the food 3. After tasting the food	• 14 • 12 • 32	• 24.14 • 20.69 • 55.17
SEE THEMSELVES AS:	1. High 2. Medium 3. Low salt users	• 6 • 39 • 13	• 10.35 • 67.24 • 22.41

The number of panellists included were specifically selected to reflect a representative sample of the White and Black population of the Free State Province. The consumer panel consisted of 58 panelists, comprising three age groups and two ethnic groups. More than half of the consumers included in the panel prepared their own food (58.62 percent). As many as 17.65 percent of these consumers indicate that they use more salt than recommended by the recipe, but only 10.34 percent also class themselves as high salt users. Although only 14.70 percent of the consumers which prepare their own food, indicate that they use no salt or less salt than stipulated by the recipe, as many as 22.14 percent class themselves as low salt users.

4.3. ANALYSIS OF SODIUM CONTENT

4.3.1 COMPOSITION TABLES

The sodium content of the dishes estimated using the "MRC Food Composition Tables" (Langenhoven et al., 1991) and the "Nutritional content of age A (13% fat) beef carcase tables" (Schönfieldt and Welgemoed, 1996:52) is presented in Table 4.2. The sodium content of the "MRC Food Composition Tables" for beef is taken from American data and thus the "Nutritional content of age A (13% fat) beef carcase tables" (Schönfieldt and Welgemoed, 1996:52) were used for the South African beef used.

Table 4.2 Sodium content of dishes as obtained from the composition tables

Food item	Mg sodium per dish weight (g)	Sodium reduction (mg)	Sodium reduction (%)
Smooth texture, simple dish			
A = normal	1331.88		
B = 1/3 reduction	884.16	A-B 447.72	33.62
C = 2/3 reduction	457.66	A-C 836.22	62.78
Smooth texture, complex dish			
A = normal	5044.24		
B = 1/3 reduction	3412.54	A-B 1631.70	32.35
C = 2/3 reduction	1664.29	A-C 3379.95	67.01
Coarse texture, simple dish			
A = normal	2181.60		
B = 1/3 reduction	1365.75	A-B 815.85	37.40
C = 2/3 reduction	588.75	A-C 1592.85	73.01
Coarse texture, complex dish			
A = normal	5627.60		
B = 1/3 reduction	3218.90	A-B 2408.70	34.52
C = 2/3 reduction	2053.40	A-C 3574.20	63.50

Four dishes with normal sodium content (A), with two low-sodium counterparts (B and C), were developed. The approximately one-third reduction represented as B contained 32.35 to 37.40 percent less sodium than the normal recipe. The approximately two-third reduction represented as C, contained between 62.78 to 73.01 percent less sodium than the normal recipe.

4.3.2. CHEMICAL ANALYSIS

Table 4.3 shows the actual sodium content of the dishes as obtained from standardized chemical analyses.

Table 4.3 Sodium content of dishes as determined by standardized chemical analysis.

Food item	Mg sodium per dish weight (g)	Sodium reduction (mg)	Sodium reduction (%)
Smooth texture, simple dish			
A = normal	1326.00		
B = 1/3 reduction	850.00	A-B 476.00	35.90
C = 2/3 reduction	399.5	A-C 926.50	69.87
Smooth texture, complex dish			
A = normal	4971.20		
B = 1/3 reduction	3346.00	A-B 1625.20	32.70
C = 2/3 reduction	1596.52	A-C 3374.68	67.88
Coarse texture, simple dish			
A = normal	2011.02		
B = 1/3 reduction	1408.44	A-B 602.58	29.96
C = 2/3 reduction	1030.92	A-C 980.10	48.74
Coarse texture, complex dish			
A = normal	5574.00		
B = 1/3 reduction	3158.60	A-B 2415.40	43.33
C = 2/3 reduction	1950.90	A-C 3623.10	65.00

The results show the sodium content of dishes as determined by standardized chemical analysis of the four dishes with normal sodium content (A), and the two low-sodium counterparts (B and C). The approximately one-third reduction represented as B contained 29.96 to 43.33 percent less sodium than the normal recipe. The approximately two-third reduction represented as C, contained between 48.74 to 69.87 percent less sodium than the normal recipe.

4.3.3 RELATIONSHIP BETWEEN COMPOSITION TABLES AND CHEMICAL ANALYSIS

The difference in the sodium content determined by the "MRC Food Composition Tables" (Langenhoven et al., 1991), the "Nutritional content of age A (13% fat) beef carcase tables (Schönfieldt and Welgemoed, 1996:52) and chemical analysis are represented in Table 4.4.

Table 4.4 Difference in sodium content determined by composition tables and chemical analysis .

Food item	**"MRC Food Composition Tables" (mg sodium per 100g)**	**Chemical Analysis (mg sodium per 100g)**
Smooth texture, simple dish		
A = normal	156.58	156
B = 1/3 reduction	99.28	100
C = 2/3reduction	53.76	47
Smooth texture, complex dish		
A = normal	527.62	520
B = 1/3 reduction	356.90	350
C = 2/3 reduction	174.06	167
Coarse texture, simple dish		
A = normal	268.32	277
B = 1/3 reduction	187.19	194
C = 2/3 reduction	133.75	142
Coarse texture, complex dish		
A = normal	302.88	300
B = 1/3 reduction	173.25	170
C = 2/3 reduction	110.50	105

The correlation between sodium content determined by composition tables and chemical analysis was calculated to determine whether the differences were significant (Table 4.5).

Table 4.5. Correlation between sodium content determined by composition tables and chemical analysis.

Variables	**Cases**	**Correlation**	**p-value**
• Composition tables • Chemical tests	• N = 12	• 0.998903	• 0.000000

The results in Table 4.5 indicates a highly significant correlation between the sodium content determined by the "MRC Food Composition Tables" and "Nutritional content of age A (13% fat) beef carcase tables" and chemical analysis. The 12 cases referred to, include the three sodium concentrations for each of the four dishes investigated.

4.4. SENSORY EVALUATION OF ACCEPTABILITY AT THREE SODIUM LEVELS

Figure 4.1 to Figure 4.6 show the analysis of the difference in the magnitude of the means of the three sodium levels ([A] normal sodium level in dish; [B] approximately one-third sodium reduction and [C] approximately two-third sodium reduction).

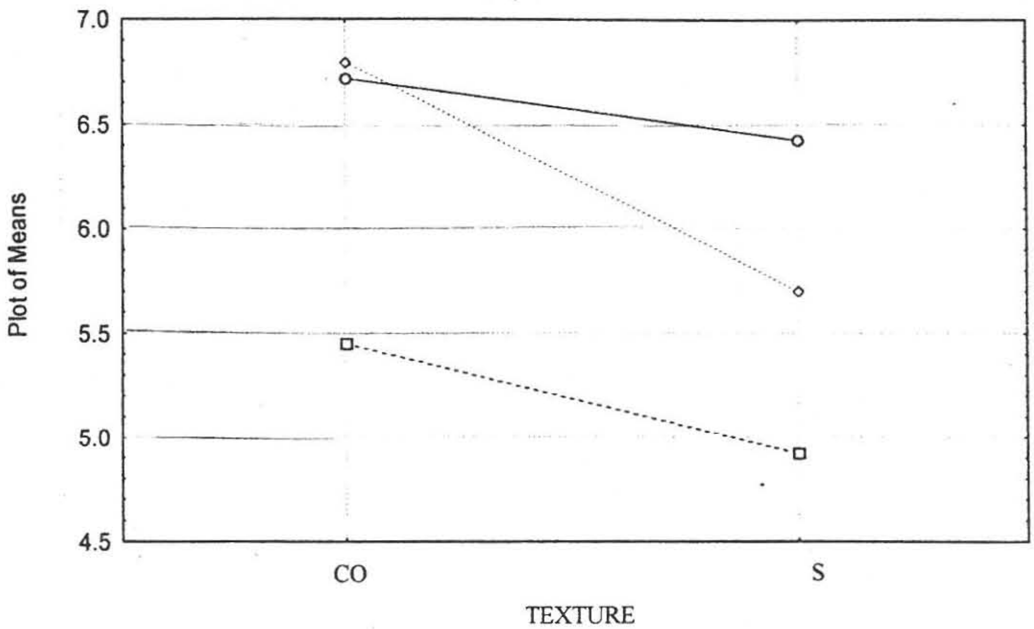
Since the main aim of the study was to investigate the acceptability and salt perception of dishes with reduced sodium levels, it was decided to focus further analyses and discussion on paired difference tests for this, the main factor (sodium levels). The researcher therefore tested mean differences between the three levels of the main factor (sodium levels), at the four texture and complexity combinations, in a pair wise manner (twelve tests) (See 4.6). Therefore, Figure 4.1 to Figure 4.6 will not be discussed.

Figure 4.1. to 4.3 show the profile of acceptability means of the different dishes. The three main factors evaluated are as follows:

- Complexity with regard to the number of ingredients: simple (SI) and complex (COM) dishes

- Sodium levels: (A) normal sodium level in dish; (B) approximately one-third sodium reduction and (C) approximately two-third sodium reduction.
- Texture: smooth (S) and coarse (CO).

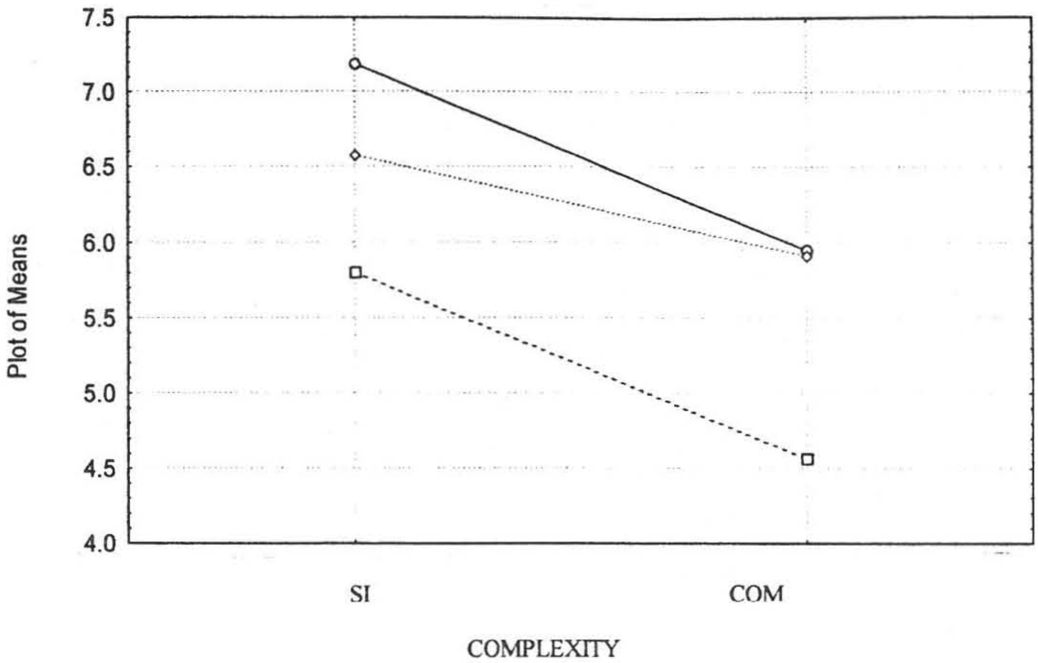
The influence of the dish texture (smooth [S] and coarse [CO]), on the three sodium levels, is presented in Figure 4.1.



0 = A: Normal sodium level
◆ = B: Approximately one third sodium reduction
☐ = C: Approximately two third sodium reduction

*Mean on scale 1 to 9: 9 = Like extremely; 1 = Dislike extremely
*Texture: Co = coarse and S = Smooth

Figure 4.1. Profile of mean acceptability at the three sodium levels and two dish textures.



0 = A: Normal sodium level

◆ = B: Approximately one third sodium reduction

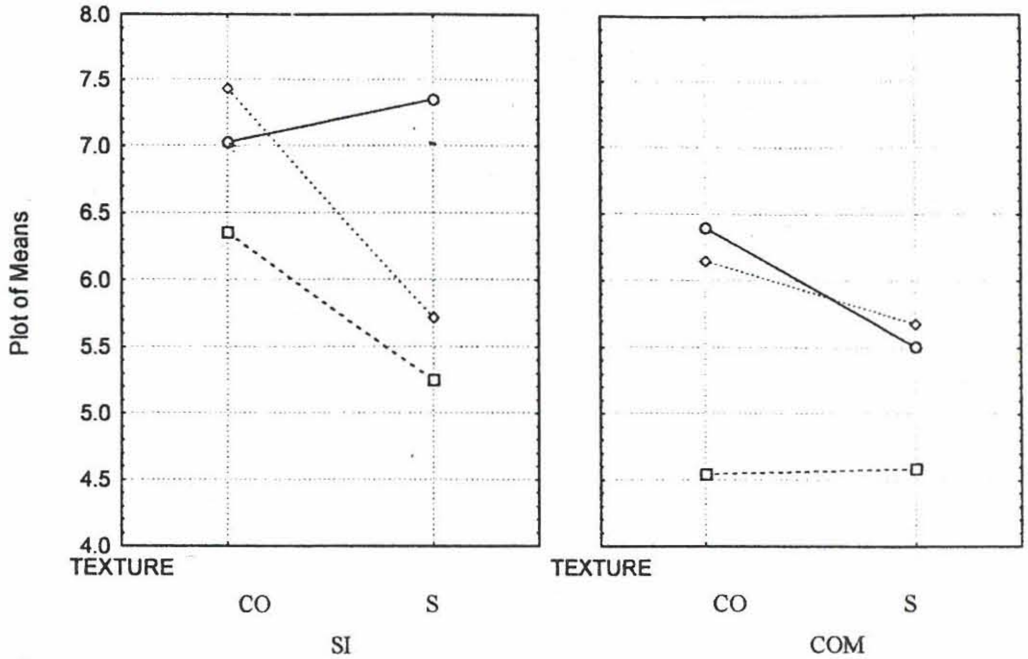
□ = C: Approximately two third sodium reduction

*Mean on scale 1 to 9: 9= Like extremely; 1 = Dislike extremely

*Complexity: SI = simple and COM = complex

Figure 4.2 Profile of mean acceptability at three sodium levels and two complexities

The results shown in Figure 4.2 indicate that the acceptability of the sodium level in the dish could possibly influenced by the complexity (coarse [CO] and smooth [S]) of the dish.



0 = A: Normal sodium level

♦ = B: Approximately one third sodium reduction

☐ = C: Approximately two third sodium reduction

*Mean on scale 1 to 9: 9 = Like extremely; 1 = Dislike extremely

*Texture: Co = coarse and S = smooth

*Complexity: SI = simple and COM = complex

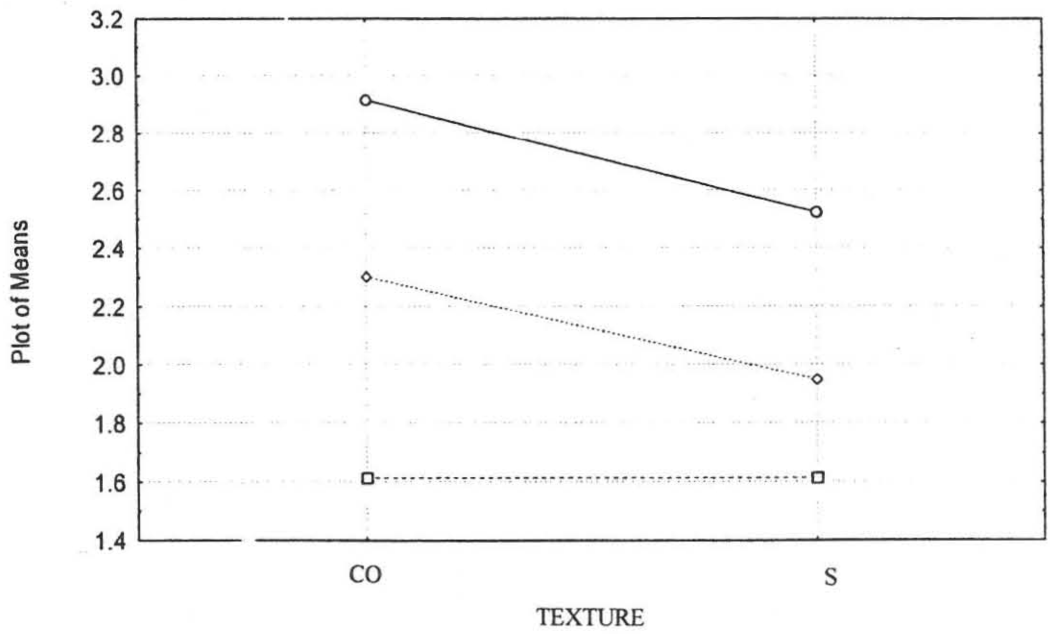
Figure 4.3. Profile of the influence of texture and complexity on mean acceptability.

Figure 4.3. shows that the dish complexity with regard to the number of ingredients [SI] simple and [COM] complex) and the texture ([S] smooth and [CO] coarse), could both possibly contributed to sensory variation.

4.5 SENSORY EVALUATION OF SALT PERCEPTION AT THE THREE SODIUM LEVELS

Figure 4.4. to 4.6 show the profile of salt perception means of the different dishes. The three main factors are as follows:

- Complexity with regard to the number of ingredients: simple (SI) and complex (COM) dishes
- Sodium levels: (A) normal sodium level in dish; (B) approximately one-third sodium reduction and (C) approximately two-third sodium reduction.
- Texture: smooth (S) and coarse (CO).

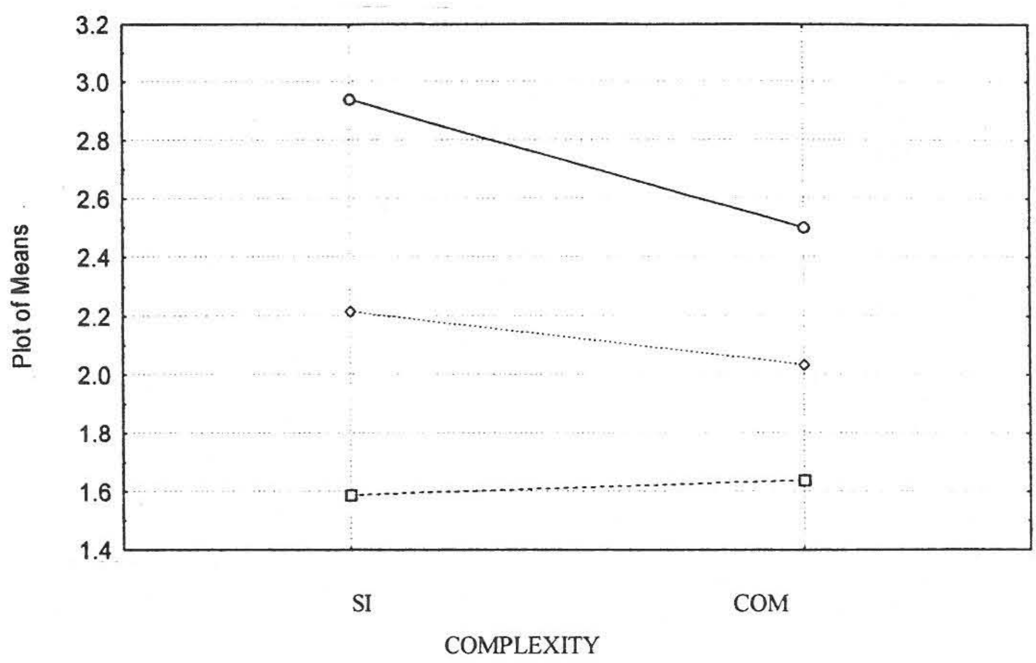


0 = A: Normal sodium level
◆ = B: Approximately one third sodium reduction
☐ = C: Approximately two third sodium reduction

*Mean on scale 1 to 5: 1 = Tasteless (not salty at all); 5 = Too salty, no longer tasty
*Texture: Co = coarse and S = smooth

Figure 4.4 Profile of mean salt perception and two dish textures.

Figure 4.4. shows that salt perception could possibly be influenced by the two texture levels; smooth (S) and coarse (CO).

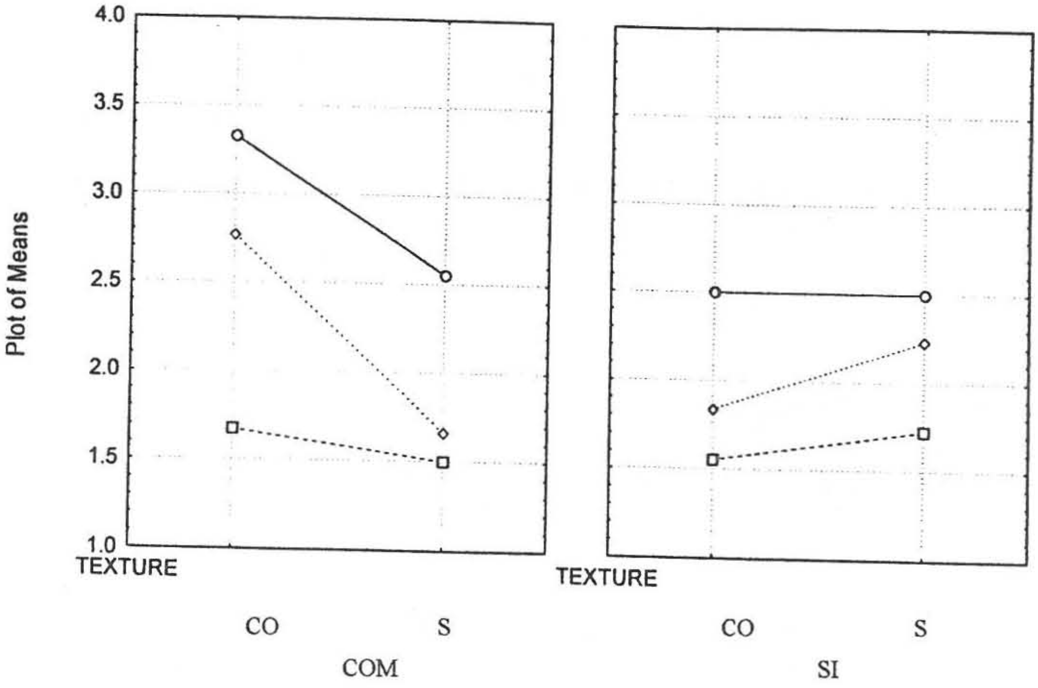


0 = A: Normal sodium level
◆ = B: Approximately one third sodium reduction
☐ = C: Approximately two third sodium reduction

*Mean on scale 1 to 5: 1 = Tasteless (not salty at all); 5 = Too salty, no longer tasty
*Complexity: SI = simple and COM = complex

Figure 4.5 Profile of mean salt perception at three sodium levels and two dish complexities

In Figure 4.5 the effect of dish complexity and salt perception are indicated.



0 = A: Normal sodium level

◆ = B: Approximately one third sodium reduction

□ = C: Approximately two third sodium reduction

*Mean on scale 1 to 5: 1 = Tasteless (not salty at all); 5 = Too salty, no longer tasty

*Texture: Co = coarse and S = smooth

*Complexity: SI = simple and COM = complex

Figure 4.6 Profile of mean salt perception for two dish textures and two complexities.

Figure 4.6 depicts the interaction between dish texture ([S] smooth and [CO] coarse) and dish complexity ([SI] simple and [COM] complex) and the influence on the mean salt perception at different sodium levels (A, B and C).

4.6 DIFFERENCE IN THE MAGNITUDE OF THE MEAN OF THE THREE SODIUM LEVELS

Analysis of the difference in the magnitude of the means of the three sodium levels ([A] normal sodium level in dish; [B] approximately one-third sodium reduction and [C] approximately two-third sodium reduction), on the numerical axes of Figure 4.1 to Figure 4.6, is given in this section.

Interaction was suspect because of non-parallel profiles. It should be noted that statistical tests are not applied to the face value of the means illustrated above, but rather to paired difference tests, which are more appropriate.

Highly significant interactions for both variables (p-level = 0,0001 for acceptability and 0,0113 for salt perception) (three way interaction between the three factors), were found. This is an important finding, since the researchers have identified an interaction effect between texture, sodium levels and complexity, which cannot be ascribed to the use of the same trial subjects, since the latter interaction was already accounted for by applying the repeated measures type of analysis.

This implies that post-hoc tests should be carried out comparing all twelve level-combination means. Some literature suggests performing many one-way ANOVA's for all level combinations, but in this case the researchers would once again have to perform repeated measures analyses of variance.

Since the whole aim of the study was to investigate the acceptability and salt perception of dishes with reduced sodium levels, it was decided to focus further analyses on paired difference tests for this, the main factor. The researchers therefore tested mean differences between the three levels of the mean factor (sodium levels), at the four texture and complexity combinations, in a pair wise manner (twelve tests).

In a similar fashion, one could keep the sodium level constant, and perform paired-difference comparisons between the textures or between the complexities (with the alternate factor at its two levels). As pointed out previously, the researchers chose not to saturate our study with analyses which did not form the mainstream of our project.

4.6.1. ACCEPTABILITY

Table 4.6 shows the results of the paired difference t-tests with regards to the sodium concentration on the acceptability ratings, which were performed because of the highly significant two-way and three-way interaction observed between the three factors (three sodium levels, two textures and two levels of complexity).

Table 4.6. Effects of sodium concentration on acceptability ratings

Food item	**Mean acceptability** [a]	**Pairs** ♣ [b] NS [c]	**p-value**
Smooth texture, simple dish			
A = normal	7.35	A – B ♣	0. 000000
B = 1/3 reduction	5.72	A – C ♣	0. 000000
C = 2/3 reduction	5.25	B – C NS	0. 142780
Smooth texture, complex dish			
A = normal	5.51	A – B NS	0. 591710
B = 1/3 reduction	5.68	A – C ♣	0. 019214
C = 2/3 reduction	4.59	B – C ♣	0. 062407
Coarse texture, simple dish			
A = normal	7.03	A – B NS	0. 137540
B = 1/3 reduction	7.43	A – C ♣	0. 062407
C = 2/3 reduction	6.35	B – C ♣	0. 001016
Coarse texture, complex dish			
A = normal	6.40	A – B NS	0. 470300
B = 1/3 reduction	6.15	A – C ♣	0. 000016
C = 2/3 reduction	4.54	B – C ♣	0. 000002

(a) Scale 1 to 9: 9 = Like extremely; 1 = Dislike extremely

(b) NS = Not significant

(c) ♣ = Significantly different at 95% level

Table 4.6 shows the effects of sodium concentration on acceptability ratings and indicates that the acceptability ratings for the approximately one-third sodium reduced version of the simple dish with a smooth texture were significantly lower than the regular counterpart (A–B p-value = 0.000000089000), with a sodium reduction of 476.00 mg (35.58 percent) as seen in Table 4.3. The sodium reduction of the other three dishes were reduced by similar amounts, 29.94 percent to 43.33 percent (see Table 4.3), yet these dishes were found to be as acceptable as their counterparts that were higher in sodium.

4.6.2 SALT PERCEPTION

Table 4.7 shows the results of the paired difference t-tests with regards to the sodium concentration on the salt perception ratings.

Table 4.7. Effects of sodium concentration on salt perception ratings

Food item	**Mean salt perception** [(a)]	**Pairs** ♣ [(b)] NS [(C)]	**p-value**
Smooth texture, simple dish			
A = normal	2.55	A – B ♣	0. 000000
B = 1/3 reduction	1.66	A – C ♣	0. 000000
C = 2/3 reduction	1.50	B – C NS	0. 334690
Smooth texture, complex dish			
A = normal	2.50	A – B NS	0. 140370
B = 1/3 reduction	2.23	A – C ♣	0. 000027
C = 2/3 reduction	1.72	B – C ♣	0. 007002
Coarse texture, simple dish			
A = normal	3.33	A – B ♣	0. 000097
B = 1/3 reduction	2.77	A – C ♣	7. 3604 E-17
C = 2/3 reduction	1.67	B – C ♣	0. 000000
Coarse texture, complex dish			
A = normal	2.50	A – B ♣	0. 000047
B = 1/3 reduction	1.84	A – C ♣	0. 000006
C = 2/3 reduction	1.55	B – C NS	0. 068427

(a) Scale 1 to 5: 5 = Too salty, no longer tasty; 1 = Tasteless (not salty at all)

(b) NS = Not significant

(c) ♣ = Significantly different at 95% level

In the complex dish with a smooth texture, the sodium concentration reduction was not significantly perceived with a one-third reduction (A–B p-value = 0.140370). This represents a sodium reduction of 32.70 percent (see Table 4.3). In contrast, however, at a two-third reduction (A–C p-value = 0.000027), which represents a sodium reduction of 67.88 percent (see Table 4.3), the reduction in sodium concentration was significantly perceived.

In the approximately one-third reduction in sodium version of simple dishes with a smooth texture, the difference in sodium concentration was perceived significantly (A–B p-value = 0.000000098148). This represents a sodium reduction of 35.90 percent (see Table 4.3). Interesting to note is that there was no difference in salt perception of the one-third and two-third reduction in the simple dish with a smooth texture. This represents a sodium reduction of 69.87 percent (see Table 4.3). This was also true for the complex dish with a coarse texture (with a sodium reduction of [A-C] 65.00 percent), as seen in Table 4.3.

4.7. DIFFERENCE IN THE MAGNITUDE OF THE MEAN ACCEPTABILITY AND MEAN SALT PERCEPTION FOR DIFFERENT AGE GROUPS

4.7.1 ACCEPTABILITY

Table 4.8. shows the mean acceptability rating and significance of mean difference of all the dish combinations between the three age groups (group one = 17 to 30 years, group two = 30 to 50 years and group three = 50^{+}).

Table 4.8. Mean acceptability rating and significance of mean differences between the three age groups

Age group[a]	Food item	Sodium levels	Mean[b] per age group	NS[c] or ♣ [d]	p-value
• Group one (17 - 30) • Group two (30 - 50)	Coarse texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Coarse texture, complex dish	A = normal	• 5.58 • 7.40	♣	0. 014371
	Smooth texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, complex dish	A = normal	• 4.38 • 6.58	♣	0. 013220
• Group one (17 – 30) • Group three (50+)	Coarse texture, simple dish	C = 2/3 reduction	• 5.60 • 7.17	♣	0. 035317
	Coarse texture, complex dish	B = 1/3 reduction	• 5.40 • 7.25	♣	0. 013420
	Smooth texture, simple dish	B = 1/3 reduction	• 5.21 • 7.25	♣	0. 001707
		C = 2/3 reduction	• 4.40 • 6.75	♣	0. 001447
	Smooth texture, complex dish	A = normal	• 4.39 • 6.50	♣	0. 033931
		B = 1/3 reduction	• 5.40 • 7.25	♣	0. 007418
		C = 2/3 reduction	• 3.67 • 6.54	♣	0. 001795

Table 4.8. Mean acceptability rating and significance of mean differences between the three age groups (Continued).

Age group[a]	**Food item**	**Sodium levels**	**Mean[b] per age group**	**NS[c] or ♣ [d]**	**p-value**
• Group two (30 – 50) • Group three (50^+)	Coarse texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Coarse texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, simple dish	B = 1/3 reduction	• 7.83 • 7.25	♣	0. 003937
	Smooth texture, complex dish	C = 2/3 reduction	• 4.60 • 6.54	♣	0. 025016

(a) Age groups: One = 17 to 30; Two = 30 to 50; Three = 50^+
(b) Scale 1 to 9: 9 = Like extremely; 1 = Dislike extremely
(c) NS = Not significant
(d) ♣ = Significantly different at 95% level

* **Group one and two**

A significant acceptability mean rating difference (p-value = 0.014371 and p-value p = 0.013220) was found in only two of the four dish combinations (coarse, complex and smooth, complex) between age group one (17 to 30) and two (30 to 50). These significant acceptability differences appeared already in the normal sodium level (A). It thus seems as if the dish complexity (number of ingredients per dish) plays a greater role than texture (coarse and smooth). No significant difference in the average acceptability in the approximately one third (B) and the approximately two third (C) sodium reduction in all the dish combinations, between these age groups (17 to 30 and 30 to 50) was found.

* **Group one and three**

The most significant acceptability mean differences where observed between group one (17 to 30) and group three (30 to 50) independent of the dish combination or sodium level. At the normal sodium level (A) a significant acceptability mean difference (p-value = 0.0033931) in the complex dish with a smooth texture, was found between age groups one (17 to 30) and three (30 to 50).

With the reduction of approximately one third sodium (B), in three of the four dish combinations (coarse, complex; smooth, simple and smooth, complex) a significant acceptability mean difference (p-value = 0.01342; p-value = 0.001707 and p-value = 0.007418) was observed. With a reduction of approximately two thirds sodium (C), in three of the four dish combinations (coarse, simple; smooth, simple and smooth, complex) a significant acceptability mean difference (p-value = 0.001795) was seen.

* **Group two and three**

Only two significant mean acceptability differences were seen between these age groups (30 to 50 and 50^{+}), namely in approximately two third sodium reduction (C) in the smooth, complex dish (p-value = 0.025016) and approximately one third sodium reduction (B), smooth, simple dish (p-value = 0.003937). From Table 4.7. it is clear that the most significant mean differences in acceptability are between the youngest and oldest age groups. The older groups (group two: 30 to 50 and group three: 50^{+}) most often gave a higher acceptability rating than the younger group (group one: 17 to 30).

4.7.2 SALT PERCEPTION

Table 4.9. shows the mean salt perception rating and significance of mean difference of all the dish combinations between the three age groups (group one = 17 to 30 years, group two = 30 to 50 years and group three = 50^{+}).

Table 4.9. Mean salt perception rating and significance of mean differences between the three age groups

Age group[a]	**Food item**	**Sodium levels**	**Mean**[b] **per age group**	**NS**[c] **or ♣** [d]	**p-value**
• Group one (17 - 30) • Group two (30 - 50)	Coarse texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Coarse texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction	• 1.98 • 2.73 • 2.28 • 1.38 • 1.21 • 1.98	♣ ♣ ♣	0. 015734 0. 005632 0. 043373
	Smooth texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
• Group one (17 – 30) • Group three (50^{+})	Coarse texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Coarse texture, complex dish	A = normal B = 1/3 reduction	• 1.98 • 3.25 • 2.08 • 1.38	♣ ♣	0. 000173 0. 022278
	Smooth texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05

Table 4.9. Mean salt perception rating and significance of mean differences between the three age groups (Continued).

Age group[a]	Food item	Sodium levels	Mean[b] per age group	NS[c] or ♣ [d]	p-value
◆ Group two (30 – 50) ◆ Group three (50^{+})	Coarse texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Coarse texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, simple dish	A = normal	◆ 2.75 ◆ 2.08	♣	0. 036951
	Smooth texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05

(a) Age groups: One = 17 to 30; Two = 30 to 50; Three = 50^{+}

(b) Scale 1 to 5: 5 = Too salty, no longer tasty; 1 = Tasteless (not salty at all)

(c) NS = Not significant

(d) ♣ = Significantly different at 95% level

* **Group one and two**

A significant salt perception mean rating difference was found only in one of the four dish combinations (coarse, complex), but in all three the sodium levels ([A] p-value = 0.015734; [B] p-value = 0.005632 and [C] p-value = 0.043373). It thus seems as if the dish combination coarse complex plays a great role with regard to salt perception (between age group one [17 to 30] and group two [30 to 50]).

* **<u>Group one and three</u>**

Only two significant mean salt perception differences were seen between the age groups one (17 to 30) and three (50^{+}), namely in the normal sodium level (A) as well as in the one third sodium reduced version (B) in the coarse, complex dish (p-value = 0.000173 and p-value = 0.022278). It thus seems as if a coarse dish texture and complex dish composition are perceived differently between age groups one (17 to 30) and three (50^{+}).

* **<u>Group two and three</u>**

A significant salt perception mean rating difference (p-value = 0.036951) was found only in one of the four dish combinations (smooth, simple) between age group two (30 to 50) and three (50^{+}). These significant salt perception differences appeared already in the normal sodium level (A). There is no significant difference in the mean salt perception in the approximately one third (B) and the approximately two third (C) sodium reduction in all the dish combinations between these age groups (30 to 50 and 50^{+}).

4.8. DIFFERENCE IN THE MAGNITUDE OF THE MEAN ACCEPTABILITY AND MEAN SALT PERCEPTION FOR DIFFERENT SALT USER TYPES

4.8.1. ACCEPTABILITY

Table 4.10. shows the mean acceptability rating and significance of mean differences of the dish combinations between the three perceived salt user types (user type one = high salt user, user type two = medium salt user and user type three = low salt user).

Table 4.10. Mean acceptability rating and significance of mean differences between the three perceived salt user types.

Salt user types[a]	Food item	Sodium levels	Mean[b] per salt user type	NS[c] or ♣ [d]	p-value
• User type one (High) • User type two (Medium)	Coarse texture, simple dish	C = 2/3 reduction	• 8.08 • 5.77	♣	0. 010642
	Coarse texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05

Table 4.10. Mean acceptability rating and significance of mean differences between the three perceived salt user types (Continued).

Salt user types[(a)]	Food item	Sodium levels	Mean[(b)] per salt user type	NS[(c)] or ♣ [(d)]	p-value
• Type one (High) • Group three (Low)	Coarse texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Coarse texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, complex dish	C = 2/3 reduction	• 2.83 • 5.84	♣	0. 010956
Type two (Medium) Type three (Low)	Coarse texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Coarse texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05

(a) Salt user type: One = High; Two = Medium; Three = Low

(b) Scale 1 to 9: 9 = Like extremely; 1 = Dislike extremely

(c) NS = Not significant

(d) ♣ = Significantly different at 95% level

* **Salt user type one and two**

A significant acceptability mean rating difference (p-value = 0.010642) was found only in one of the four dish combinations (coarse, simple) between salt user type one (high) and two (medium). This significant acceptability differences was observed in the two third sodium reduced version (C).

* **Salt user type one and three**

The only significant acceptability mean difference was found between salt user type one (high) and three (low) (p-value = 0.010956) in the smooth complex dish at a two third sodium reduction (C).

* **Salt user type two and three**

No significant differences were observed in the average acceptability of all four the dish combinations, at all sodium levels (A, B, C) between the consumers that considered themselves to be medium salt user types and low salt user types.

4.8.2. SALT PERCEPTION

The results in Table 4.11. shows the mean salt perception rating and significance of mean difference of all the dish combinations between the three perceived salt user types

Table 4.11. Mean salt perception rating and significance of mean differences between the three perceived salt user types.

Salt user types[a]	Food item	Sodium levels	Mean[b] per salt user type	NS[b] or ♣ [c]	p-value
• User type one (High) • User type two (Medium)	Coarse texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Coarse texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05

Table 4.11. Mean salt perception rating and significance of mean differences between the three perceived salt user types (Continued).

Salt user types[a]	Food item	Sodium levels	Mean[b] per salt user type	NS[b] or ♣ [c]	p-value
• Type one (High) • Group three (Low)	Coarse texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Coarse texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, simple dish	B = 1/3 reduction	• 1.00 • 1.92	♣	0. 014071
	Smooth texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
• Type two (Medium) • Type three (Low)	Coarse texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Coarse texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, simple dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05
	Smooth texture, complex dish	A = normal B = 1/3 reduction C = 2/3 reduction		NS	> 0.05

(a) Salt user type: One = High; Two = Medium; Three = Low

(b) Scale 1 to 5: 5 = Too salty, no longer tasty; 1 = Tasteless (not salty at all)

(c) NS = Not significant

(d) ♣ = Significantly different at 95% level

In all the dish combinations and all the user type combinations only one significant salt perception mean difference rating was found. This occurred between user type one (high) and three (low), in the one third sodium reduction (B) in the dish combination smooth texture, simple dish (p-value = 0.014071).

4.9. SUMMARY

The results obtained from the demographic questionnaire indicate that most of the consumers used more salt in food preparation than recommended by the recipe, but did not consider themselves to be high salt users.

The results of the paired difference t-tests with regard to the sodium concentration on the acceptability ratings indicate that sodium levels can be reduced by thirty percent without significantly reducing acceptability. Foods/dishes with a smooth texture and complex nature and coarse texture with either simple or complex nature were found to be more acceptable than simple dishes with a smooth texture.

The results of the t-tests with regard to the sodium concentration on the salt perception ratings indicate a significant salt perception reduction in three of the four dishes with a one third sodium reduction. These results suggest that sodium concentration alone does not determine salt perception in food systems.

Results of the mean acceptability and salt perception ratings and significance of mean difference of all the dish combinations between the three age groups (group one = 17 to 30 years, group two = 30 to 50 years and group three = 50^{+}) indicate that age-related taste differences exist and that the most preferred concentration in a series differs between age groups No significant differences were found between the different salt user types.

CHAPTER 5

DISCUSSION OF RESULTS

5.1 INTRODUCTION

The main objective of this study was to assess the magnitude of sodium reduction that can be made without significantly changing the perception of saltiness or decreasing the acceptability of a broad range of home-prepared food items.

In this chapter, limitations of the study will be pointed out as well as the effect that they could have had on the results. Secondly, differences in the magnitude of the means at the three sodium levels will be discussed in order to indicate whether food acceptability and the perception of saltiness are associated with sodium concentration. Thereafter, the mean acceptability and salt perception of different age groups and different salt user types will be discussed.

Throughout the discussion the trends and differences that were observed will be highlighted. Where possible the results obtained in this study are compared to the results of other similar studies, as reported in the available literature. Although a number of studies have investigated salt intake and depletion, very few have determined the level of sodium reduction that can be made without significantly affecting acceptability and perception.

5.2. LIMITATIONS OF THE STUDY

The limitations of the study as regards the questionnaire, panel composition and the sodium concentration will henceforth be discussed.

5.2.1. QUESTIONNAIRE LIMITATIONS

Question seven (Appendix G) is included in order that the users could classify themselves as high, medium or low salt users. According to the results obtained (Table 4.1.) it seems as if the panellists could not accurately quantify their daily salt intake (additional salt added as well as natural salt present in food). Additional questions related to salt intake could have lead to a better identification of high, medium and low salt users.

The inclusion of a question regarding the period that consumers had lived in an urban area could have contributed to the value of the study. It is assumed that persons included in the sensory evaluation panel had already adapted to the Western diet.

5.2.2. PANEL COMPOSITION LIMITATIONS

Most of the panel participants in the age group 50 and older were illiterate. This led to difficulty in answering questions as well as completing the evaluation forms. The problem was overcome by including fewer consumers per evaluation session in this age group so that questionnaires and evaluation forms could be completed on their behalf. Interpreters were also used during information sessions to ensure that instructions were understood clearly.

The same fifty-eight subjects were used at each of the twelve level combinations; thus a three way repeated measures/factors Analysis of Variance (ANOVA) instead of the standard three way factor Analysis of Variance (ANOVA) was used to analyze the data.

In this study, no association between acceptability and salt perception was determined. Thus, results and recommendations regarding acceptability and salt perception are not associated. However, adherence to sodium restricted diets are mainly determined by high acceptability ratings, with the perception of saltiness playing a secondary role.

5.2.3. SODIUM CONCENTRATION LIMITATIONS

Most research investigating acceptability and salt perception, have made use of aqueous solutions in which the sodium concentration was the only factor that varied (Murphy and Gilmore, 1990:33). In this study the aim was to evaluate the acceptability and perception of food with different compositions and textures. We thus made use of the usual sodium levels (as found in the original recipes) of home-prepared food items, which differ from dish to dish. For this reason we were unable to determine the specific sodium concentration at which adaptation to sodium takes place, as well as if foods loaded with sodium (higher sodium concentrations) was more acceptable or perceived more salty than the normal sodium concentration.

On the other hand, the aqueous solutions used by most research investigating acceptability and salt perception stimuli, may not always present a clear picture of "real-world" preferences of humans. This study was conducted with food instead of solutions and contained both olfactory and gustatory stimuli. Thus, the role played by texture and complexity found in food, together with sodium concentrations usually ingested (as well as at reduced concentrations) in the perception of saltiness and acceptability of food could be determined.

5.3 DIFFERENCE IN THE MAGNITUDE OF THE MEAN OF THE THREE SODIUM LEVELS

5.3.1. ACCEPTABILITY

The results in Table 4.6 indicate that a sodium reduction of approximately one third is possible, within a specific dish combination without negatively influencing acceptability. However, with a sodium reduction below the adaptation level for salt, acceptability decreases significantly. It also seems as if dish complexity (number of ingredients per dish) influences consumer acceptability to a larger degree than dish texture.

The major acceptability findings in this study show that a reduction of approximately one third in sodium did not lower the acceptability of complex dishes with either a smooth or coarse texture or that of simple dishes with a coarse texture. These results seem to indicate that it is possible to reduce the sodium content in dishes with a complex composition, with about thirty percent, without significantly changing the consumer acceptability.

These findings are supported by data from other studies (Mattes, 1987:133 and Bertino, 1982b: 1140) that show that when mixtures are constructed from substances with different taste qualities, most salts evoke more than one quality. These other tastes evoked by salt may mask the one third sodium reduction. Lawless and Heymann (1998:46) also indicate that at low concentrations salt tastes sweet. This sweet taste can possibly occur in dishes with a one third sodium reduction and may be the reason for the relatively high acceptability.

It seems as if, together with the masking effect that takes place within complex dishes (mixtures of substances with different taste qualities) with reduced sodium content, partial adaptation also takes place. Partial adaptation contributes to the masking effect brought about by other tastes evoked by salt in mixtures with different taste qualities as well as the sweet taste of low salt concentrations, and thus prevents a decrease in acceptability from occurring.

Kroeze (1990:48) uses the example of a freshly painted restaurant with a noticeable paint smell immediately after entering, to explain the role of mixtures constructed from substances with different taste qualities (complex dish) and the effect of taste adaptation. He states that after a while the uniformly dispersed odour of the paint becomes less noticeable because of sensory adaptation, while the non-uniformly distributed food odours are still noticed. Non-uniformly distributed taste substances in a food product (for example the different ingredients in the complex dishes of beef stew and vegetable soup used in this study) may have given rise to a unique pattern of only partial adaptation equilibria, which gradually changes while chewing. Thus, there is a continuous perception of the different tastes that may contribute to the masking of the approximately one third sodium reduction.

There may be a further advantage of partial adaptation. In one of McBurney et al., (as cited by Kroeze, 1990:49) experiments, McBurney and partners show that this partial adaptation leads to the loss of absolute sensitivity, but in turn increases differential sensitivity.

McBurney and partners indicate that absolute sensitivity is the sensitivity to a specific taste or one of the basic tastes, often associated with a specific dish. For example, when a food/dish that is usually salty is eaten, the taste receptors are more sensitive to the expected taste and less sensitive to the secondary tastes that are also present in the dish.

Differential sensitivity is the sensitivity for all the tastes (the most prevalent/main taste in combination with the secondary tastes) present in a dish. Thus, where absolute sensitivity focuses on one specific taste, differential sensitivity is associated with a combination of taste receptors of different tastes (often during partial adaptation). In this case absolute sensitivity decreases, while differential sensitivity increases.

Thus, moderate sodium reduction (approximately one third) together with partial taste adaptation (most often observed in complex dishes) results in a decrease in salt perception because of the loss in absolute sensitivity, while acceptability ratings remain unchanged (see non-significant changes in coarse dishes with approximately one third sodium reduction, Table 4.6), because of the increase in differential sensitivity.

The results in Table 4.6 also indicate that dish texture plays an important role in the acceptability of different sodium concentrations in dishes, although to a lesser degree than complexity.

The results of our study show that simple dishes with a coarse texture are more acceptable than simple dishes with a smooth texture. Thus, although very few studies have investigated the role of dish texture in the acceptability of dishes with different sodium levels, our study indicates that texture (coarse or smooth) in combination with a specific dish complexity (simple or complex) does influence acceptability.

Kroeze (1990:41) supports these findings and indicates that the feeling of food in the mouth is associated with texture as well as temperature. This contributes to complex perception and may contribute to perceived taste. Thus both texture and complexity should be taken into account when advising patients on sodium reduction.

These findings further support data that indicate that the salty stimuli presented in simple (e.g. mashed potatoes used in the study) or aqueous food and more complex or solid food systems (e.g. beef stew used in this study), yield different results (Bertino, 1982b:1140). This could possibly explain the significant difference in acceptability of complex dishes with a coarse texture at approximately two third sodium reduction and non-significant difference in simple dishes with a smooth texture at approximately two third sodium reduction.

An important effect of adaptation to salt on taste is that concentrations below the adapting concentration evoke a bitter-sour taste that increases in intensity as the salt concentration decreases (Beauchamp et al., 1990:888). This may explain the significant decrease in acceptability (independent of complexity or texture) observed with more than thirty-percent reduction in sodium content.

5.3.2. SALT PERCEPTION

Table 4.7 indicates that approximately one third reduction in sodium content did not significantly affect salt perception in complex dishes with a smooth texture. In other dish combinations, however, salt perception decreased significantly (Table 4.3). These results suggest that the concentration of sodium alone does not determine the perception of saltiness in food systems. Cross adaptation as well as the food used as carrier must be considered in combination with sodium concentration.

Simone et al., (1995:450) suggest that sodium interaction with sensory components may also play a role in salt perception. These findings are supported by McBurney et al., (as cited by Kroeze, 1990:49) who showed that when different taste qualities are mixed the perceived intensities are usually altered, as seen in the complex, smooth dish in this study. The perceived salt intensity mean of this dish (complex, smooth dish) is lower than that of the simple, coarse dish. Thus, with approximately one third sodium reduction, the salt perception in the complex, smooth dish was rated lower than that of the simple coarse dish.

Thus, although no association between acceptability and perception was determined in this study, it seems as if the mean salt perception ratings (in contrast to mean acceptability ratings), were most often negatively affected by mixtures of different taste qualities (dishes with a complex nature). In these dishes acceptability increased, possibly due to the increase in differential sensitivity, while salt perception most often decreased, because of the decrease in absolute sensitivity.

From the results in Table 4.7 a significant decrease in salt perception can be observed with sodium reduction in both simple dishes (with either smooth or coarse texture) used in this study. This may be an indication of considerable cross adaptation, commonly found where there are only one or similar taste qualities present in one dish (Kroeze, 1990:50).

The food used as carrier thus also determines perceived saltiness. The mean salt perception at approximately the same concentration of sodium differs according to the type of food used as a carrier. In dishes with normal sodium content, where refined cereals were used as carrier (coarse texture, simple dish [Table 4.7]), the mean salt perception rating is greater than the mean salt perception rating where meat was used as carrier (coarse texture, complex dish [Table 4.7]). In the two dishes where a vegetable-base was used as carrier, the mean salt perception ratings where either greater (smooth, complex dish) or lower (smooth, simple dish) than the mean salt perception ratings of the dishes where meat and cereals were the media in which sodium was presented. This data support the findings of Shepherd and Farleigh (as cited by Simone et al., 1995) that consumers "do not have a consistent liking for high or low salt levels across different foods."

In contrast to acceptability which seems to be influenced largely by dish complexity and to a lesser degree by texture (Table 4.6), perceived saltiness depends on the media in which sodium is presented (food used as carrier).

Literature indicates that after adapting to the westernized lifestyle and diet, cereals and cereal products provide the highest proportion of total sodium in the diet (Shank et al., 1982). The significantly perceived difference in all the sodium levels (A, B and C) of the porridge, represented as the simple dish with coarse texture in Table 4.7, could thus be expected, indicating that perception is also dish specific.

5.4 DIFFERENCE IN THE MAGNITUDE OF MEAN ACCEPTABILITY AND MEAN SALT PERCEPTION FOR DIFFERENT AGE GROUPS

5.4.1. ACCEPTABILITY

The results in Table 4.8 indicate that the older age groups (group two: 30 to 50 and group three: 50^{+}) most often gave a higher acceptability rating than the younger group (group one: 10 to 30). However, age alone does not determine the difference in acceptability ratings. Literature reports that psychological factors, health bias information (Drewnowski and Moskowitz, 1985; Shepherd, 1990) as well as the presence of hypertension (Bernard et al., 1980:407; Pragborn and Pecore, 1982) also contribute to differences in mean acceptability ratings.

The results in Table 4.8 indicate that the younger age group (group one: 17 to 30 years) and middle aged group (group two: 30 to 50 years) found the sodium concentrations (normal, approximately one third reduction and approximately two third reduction) less pleasant than the senior age group (50^+ years). The older age groups (group two: 30 to 50 and group three: 50^+) most often gave a higher acceptability rating than the younger group (group one: 10 to 30), regardless of the sodium concentration, dish texture or dish complexity.

Although other explanations are probable, the most obvious possible explanation for the higher acceptability ratings most often given by the older panelists (A; the normal sodium concentration), sodium concentration in a series of three concentrations, as used in this study, is psychological.

The higher acceptability ratings most often given by the older aged groups (50^+) at reduced concentrations (approximately one third [B] and approximately two third [C] reduction) were unexpected in view of literature that indicates that loss of taste sensitivity occurs with increasing age (Schiffman, 1991). Psychological factors such as involvement in the research project, forming part of a group and being given the opportunity to state own opinion, could possibly be reasons for higher average acceptability of all dishes.

Literature also suggest that consumers may often show a health bias in evaluating products containing loaded attributes such as salt and this may result in certain consumers (such as the elderly in our study) expressing sensory preference for a product that is in fact less acceptable than reported (Drewnowski and Moskowitz, 1985).

Due to the design of the experiment, consumers were unaware of which products contained less sodium. Although higher acceptability rating for most dishes in most sodium concentrations was observed in the elderly group when compared to the other age groups, acceptability ratings did vary within the elderly age group.

During the information session held before the sensory evaluation in this study, the association between salt intake and hypertension was explained to the consumers. The older panel members could have realized that they are the group at risk of developing hypertension and that they may benefit from a sodium reduction. This could be a reason why they rated the dishes more highly acceptable than the other age groups.

Although the blood pressure of the consumers taking part in this study was not measured, the presence of hypertension may also contribute to the higher acceptability ratings (Pragborn and Pecore, 1982) most often given by the elderly groups. The prevalence of hypertension rises with increasing age (from 45 years and especially after 60 years of age). Although literature indicate that salt thresholds increase with age (Chauncey et al., 1980:113), Bernard et al., (1980:407) indicate that aging together with hypertension or the use of antihypertensive drug therapy changes the set points and decreases salt taste thresholds.

In a study done by Murphy and Gilmore (1990:27) they indicate that in a series of concentrations, young and elderly panellists might both choose the same concentration, as the most preferred in a series of concentrations. In our study (Table 4.8. See group one and three, especially the smooth texture and complex dish), similar results can be observed. The approximately one third sodium reduction was chosen as most preferred by all age groups. Murphy and Gilmore (1990:27) also indicate that the elderly might rate the lowest concentration in the series (the approximately two third sodium reduction, in our study) and the highest concentration in the series (the normal sodium concentration, in our study) as pleasant, while the young panellists might rate those concentrations as less pleasant.

5.4.2. SALT PERCEPTION

The results in Table 4.9 indicate that age does influence the perception of salt content in different food systems and that dish composition (texture and complexity) also plays a role in the differences in salt perception between age groups.

Murphy and Gilmore (1989 as cited by Murphy and Gilmore, 1990:21) found in a study designed to test perceived intensity for individual tastes, that the greatest age-related losses appear to be associated with the perception of bitterness and the least with sweetness. In their study, salt showed no significant effect of age on the slope of psychophysical functions or on average perceived intensity. They propose that the reason may be the existence of different perceptual contexts for young and elderly subjects, and the potential influence of context on magnitude matches the context of specific types of food/dishes associated with a specific salt level that the person is used to (Murphy and Gilmore, 1990:21).

It seems that coarse dish textures and complex dishes have the greatest influence on salt perception differences between young persons (17 to 30) and middle aged groups (30 to 50) and between young people (17 to 30) and the elderly (50^{+}). Bartoshuk, (1978) indicate that because of the fact that psychophysical functions may become flattened with age, the perception of the taste of mixtures could be distorted. That may be a reason for the differences in salt perception observed between age groups.

Literature indicates that components of the overall flavour-complex may be missing from the elderly person's perception of a food flavour/taste. This demonstrates an even greater effect of age on olfactory perception than taste perception (Murphy and Gilmore, 1990:24). This may also contribute to the results indicating that complex dishes have the greatest influence on salt perception differences between the age groups (group one: 17 to30 and group two: 30 to 50, see the coarse, complex dish and group one: 17 to 30 and group three: 50^{+}, see coarse, complex dish).

The mean salt perception ratings between these age groups (17 to 30 and 30 to 50; 17 to 30 and 50^{+}) indicate that the elderly have a reduced ability to discern *intensity differences* between concentrations of salts (Schiffman, 1991).

Although age-related changes in taste intensity perception have been demonstrated in several studies (Murphy and Gilmore, 1990:20; Schiffman, 1991; Chauhan and Hawrysh, 1988:207), Enns et al., (as cited by Murphy and Gilmore, 1990:21) found no alteration in the slope of the psychophysical function for taste between adults and the elderly. In our study no significant difference in the reduced sodium concentrations (the approximately one third sodium reduction and the approximately two third sodium reduction), in all the dish combinations, between age group two: 30 to 50 (adulthood) and age group three: 50^+ (old age), were found (Table 4.9).

In this study, the mean perception ratings (Table 4.9), like the mean acceptability ratings (Table 4.8), were most often rated higher by the older aged groups than the younger group (group two: 30 to 50 in comparison to group one: 17 to 30, and group three: 50^+ in comparison to group one: 17 to30). This may be explained by literature that indicate that age-related changes in taste functioning have been demonstrated to be more quality-specific (Weiffenbach et al., 1986 as cited by Murphy and Gilmore, 1990:21).

The presence of a residual taste in the elderly (Bartoshuk et al., 1986 as cited by Chauhan and Hawrysh, 1988:215), resulting in elderly subjects giving higher ratings than young subjects to weaker taste concentrations (Chauhan and Hawrysh, 1988:215), is supported by the results from Table 4. These results show that the mean perception ratings most often given by the older age group, at approximately one third perception ratings most often given by the older age group, at approximately one third sodium reduction and approximately two third sodium reduction, is higher than the mean salt perception rating given by the younger age groups at the same sodium concentration reduction levels.

Differences in the magnitude of mean salt perception of different age groups indicates that aging affects the functioning of the chemical senses (taste, smell and trigeminal sensitivity) in significant ways (Murphy and Gilmore, 1990:20). Although the chemical senses function in connection with the perception of food flavour, each makes a unique and independent contribution to that perception (Murphy and Gilmore, 1990:19).

5.5 DIFFERENCE IN THE MAGNITUDE OF THE MEAN ACCEPTABILITY AND MEAN SALT PERCEPTION FOR DIFFERENT SALT USER TYPES

It appears that there is no difference in acceptability in dishes at different sodium levels between the different perceived salt user types (Table 4.10).

A Food Seasoning/Condiments Usage Survey used by Simone et al., (1995:451) to determine whether the additional use of salt is simply the result of a general tendency to season food highly, indicates that consumers that consider themselves to be high salt users, do not use significantly more salt, in comparison to consumers that consider themselves to be lower salt users. Our study showed the same. A lack of knowledge of sodium inherent to food, salt added (discretionary salt use i.e. table salt and cooking), salt added during food processing as well as the inability by consumers to interpret information on food labels, possibly contributed to the fact that consumers are unaware of the magnitude of daily salt consumption (table salt excluded).

5.6 SUMMARY

The major findings regarding acceptability indicate that it is possible to reduce the sodium content in dishes with a complex composition, with about thirty percent, without significantly changing consumer acceptability. The masking effect that takes place within complex dishes with reduced sodium content, partial adaptation, the decrease in absolute sensitivity while differential sensitivity increases as well as the sweet taste of low salt concentrations, seem to play a role in the lack of a decrease in acceptability of dishes with moderate reduced sodium concentrations.

Although a reduction of approximately one third in sodium content did not significantly affect salt perception in complex dishes with a smooth texture, the salt perception did decrease significantly in other dish combinations. Thus, in contrast to acceptability which seems to be influenced largely by dish complexity and to a lesser degree by texture, perceived saltiness depends on the food used as carrier, sodium interaction with other sensory components and cross adaptation.

The results also indicate that age alone does not determine the difference in acceptability and salt perception ratings. Psychological factors, health bias information as well as the presence of hypertension also contribute to differences in mean acceptability ratings. Dish composition together with age-related changes in taste functioning that become more quality-specific with aging, mainly contribute to the difference in salt perception between age groups.

The results of the difference in the magnitude of the mean acceptability and mean salt perception for different salt user types indicate that consumers are unaware of the magnitude of their daily salt consumption.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1. INTRODUCTION

The increasing prevalence of hypertension in South African communities undergoing the nutrition transition prompted us to investigate the magnitude of sodium reduction that can be made without significantly decreasing the acceptability of, or changing the salt perception of, a range of home-prepared food items.

The results of the study contribute to practical recommendations to decrease sodium intake. This may help with the prevention and treatment of hypertension through the development of a cost-effective approach for the modification of sodium in the diet.

6.2. CONCLUSIONS

6.2.1. FOODS/DISHES WITH VARYING SODIUM CONTENT

6.2.1.1 ACCEPTABILITY

With approximately one third reduction of the usual sodium content in a range of home-prepared food items the following can be concluded:

* sodium reduction is possible without significantly decreasing acceptability.
* dish complexity seems to play an important role in determining acceptability.
* dish texture should also be taken into account when making recommendations about reducing sodium content.

The major finding in this study indicates that reduction of sodium by approximately thirty percent is possible, without significantly decreasing acceptability, within dishes with a complex nature, with either a smooth or coarse texture. It thus seems as if dish complexity plays a greater role in the acceptability of a complex dish with reduced sodium content than texture.

However, the role played by texture in masking sodium reduction cannot be ignored. Especially in the case of simple dishes, where there is a lack of substances with different taste qualities, no tastes mask the sodium reduction. In cases such as this coarse dish textures are required to make a one third sodium reduction acceptable. Thus, dish texture should also be taken into account when recommending a sodium reduction.

Adaptation to salt content in dishes normally consumed changes the break points (concentration of maximum pleasantness) and influences acceptability significantly. Following a westernized diet characterized by high sodium intake for a period of time will result in a higher concentration of sodium required for a food/dish to be acceptable. Literature indicates that if sodium levels are severely restricted, about twenty percent of the sodium will be added back as table salt (Simone et al., 1995).

6.2.1.2 SALT PERCEPTION

With a systematic reduction in sodium content, the following can be concluded from this study:

* a reduction in sodium content can be made without significantly changing the perception of saltiness.
* sodium concentration alone does not determine salt perception.

Although it is necessary to consider salt interaction with sensory components when reducing the sodium content of dishes, this study indicates that sodium content can be reduced by about thirty percent, without significantly changing salt perception in complex dishes with a smooth texture. Consequently, after adaptation to the westernized lifestyle and diet, it seems that the relationship between perceived saltiness and sodium levels depends on the media in which sodium is represented.

Perceived saltiness depends on the media in which sodium is presented, rather than the sodium concentration. Where a cereal-base was used as carrier (simple, coarse dish used in this study), the differences in perceived saltiness were more significant at all the sodium concentrations.

6.2.2. AGE-RELATED DIFFERENCES

The following can be concluded:

6.2.2.1 ACCEPTABILITY

* the most preferred concentration in a series differs between age groups
* loss of basic taste intensity, with aging is not the only factor that determines acceptability
* psychological factors could play a role in acceptability of foods/dishes for elderly subjects

Different age groups prefer different sodium concentrations in a series of concentrations. Sodium concentrations were most often rated more acceptable (independent of dish texture and dish composition) by the older age groups and differed significantly from the younger age group's mean acceptability ratings. The mean acceptability ratings of young and middle age groups also differed, but not significantly.

The loss of taste intensity with aging, the desire for an overall stronger food flavour as well as age-associated olfactory changes, play a role in the difference in the mean acceptability ratings between younger and older age groups. A more complete understanding of alterations in taste, in particular, chomosensory preference in the elderly may provide some insight into dish acceptability and dietary selection by the elderly.

Since compromised nutritional status is a problem for significant numbers of elderly people (Murphy and Gilmore, 1990:20), the role of psyschological factors as well as health bias information given to elderly, must also be taken into account when planning a sodium reduced diet.

6.2.2.2 SALT PERCEPTION

* age does influence salt perception, within specific dish combinations
* age-related changes in taste are quality-specific
* the role of age-associated effects on taste are underestimated

This study indicates that the elderly have a reduced ability to discern intensity differences between salt levels.

Due to the significant influence of external factors such as psychological factors on perception, the role of age-associated effects on taste is underestimated. Thus, the mean difference in the salt perception ratings, as well as acceptability ratings, observed between the age groups (especially between the elderly and younger age group) can be attributed to the loss of taste acuity, peaking of residual taste and psychological factors.

6.2.3 DIFFERENCES BETWEEN SALT USER TYPES

Most consumers are unaware of the magnitude of their daily salt consumption.

6.3. RECOMENDATIONS

6.3.1 FOODS/DISHES WITH VARYING SODIUM CONTENT

6.3.1.1 ACCEPTABILITY

The following recommendations regarding reduction of sodium content on acceptability can be made:

Regarding the magnitude of sodium reduction that can be made without decreasing acceptability significantly, it is recommended that:

* a sodium reduction of thirty percent is an achievable dietary goal
* alteration in food preparation is required to ensure acceptability of sodium reduced foods/dishes

It is recommended that sodium content in food (investigated in this study) be reduced, by omitting added salt or by decreasing the amount added during food preparation.

Alteration in food preparation can be effective in reducing sodium consumption and it is recommended that sodium be reduced for the general public (Lang et al., 1985).

Regarding dish composition, the following combinations are recommended:

* dishes with smooth texture in combination with a complex composition,
* dishes with a coarse texture in combination with either a complex or simple composition.

It is recommended that specific food combinations should be taken into account when decreasing the sodium content by about thirty percent. Dishes with a smooth texture and complex nature, such as vegetable soup, or coarse texture with a simple or complex nature, such as porridge and beef stew, are recommended. Dishes with a smooth texture and simple nature (complexity), such as mashed potatoes, are less acceptable.

The role played by food texture and dish complexity, as determined in this study, may help to improve adherence to a sodium reduced diet. Literature also indicate that after following a low sodium diet the concentration that produced maximum pleasantness of salt in liquid food, such as soup, decreased and the rated intensity of salt in a more solid food, increased (Bertino et al., 1982a). Thus, it seems as if in most of the recommended dish compositions, acceptability and salt perception tend to increase proportionally to the duration that the above proposed diet (about thirty percent sodium reduction and specific dish composition) is followed.

When considering the hypertension problem in South Africans undergoing the Nutrition Transition, it is essential to suggest cost-effective practical methods of addressing a health related problem, such as the diet modification that is proposed in this study. It is thus recommended that hypertensive patients that need to decrease sodium intake as part of their treatment, concentrate on eating dishes with a smooth texture and complex nature, (such as vegetable soup) or coarse texture with a simple or complex nature, (such as porridge and beef stew). Dishes with a smooth texture and simple complexity (such as mashed potatoes) are not recommended.

6.3.1.2. SALT PERCEPTION

It is important to note that the association between acceptability and salt perception was not determined in this study. Therefore, recommendations regarding sodium reduction, dish complexity and dish texture, recommended to ensure acceptability are not directly related to salt perception.

As a result of this study, only recommendations to reduce the sodium content in home-prepared food items, without changing the salt perception significantly, can be made with regard to:

* adaptation to westernized diet
* the use of table salt

It is believed that high salt ingestion is a consequence of habits learned during development (Bertino et al., 1982b:148) and this explain the "salt-seeking" behaviour that occurs after adapting to the westernized diet (Bourne et al., 1993).

Perceived saltiness depends on the media in which sodium is represented rather than the sodium concentration alone. As is emphasized by Sowers and Stumbo, (1986) and WHO, (1990:37), (paragraph 1.3.1.2., Chapter 1) changes in dietary patterns with adaptation to westernized diets significantly increase sodium consumption within the urban settings. Urbanization promotes the use of fast foods, street foods and the increases the consumption of meat products, snack foods and other convience foods, all with a high sodium content. Thus, persons that habitually follow such a diet will eventually require a higher sodium concentration for a specific product to be acceptable. It is recommended that this salt threshold be taken into consideration when advising a sodium reduction.

When cereals, refined cereal products and meat products represent the main media used as carrier, it is recommended that salt used during cooking and the use of additional salt at table be limited. In this way the sodium content of the westernized diet can be reduced.

It is recommended that salt be added at the table rather than during food preparation, because literature indicates that table salt only contributes between four and ten percent of total sodium intake (Simone et al., 1994). Salt added during food preparation contributes 35-41 percent of total sodium consumption (Pietinen, 1982; Cappuccio and MacGregor, 1997a).

6.3.2. AGE-RELATED DIFFERENCES

It is recommended that sodium reduction for the elderly should be based on the art of balancing individualized nutrition advice with health needs, lifestyle factors and taste preferences. Psychological factors need to be considered.

6.3.3. DIFFERENCES BETWEEN SALT USER TYPES

Regarding the fact that consumers are unaware of their daily salt consumption, consumer education is recommended and essential to address the diet modification that we propose. Lang et al., (1985) also suggest that it is important to expand the consumer's knowledge of the sodium content of food.

Literature also indicate that education is essential to ensure an understanding of the principles of a low-sodium diet for consumers (Wilber, 1982) and that education is one of the keys to understanding how to combat problems experienced with sodium-controlled diets (Kris-Etherson, 1982).

6.4. RECOMMENDATIONS FOR FURTHER STUDIES

As a result of this study, certain recommendations for further studies, can be made:

* The interaction between the acceptability and perception of tastes in specific media should be investigated

* The interaction between diet, taste thresholds, preference and acceptability, especially within the elderly, merits further study.

* Studies comparing macro nutrient content of the diet and sodium consumption could be useful.

6.5. SUMMARY

It can be concluded that sodium content can be reduced by one third without significantly decreasing the acceptability of a broad range of home-prepared food items. It is, however, necessary to consider salt interaction with sensory components and media in which sodium is presented, when making recommendations regarding sodium restriction.

Sodium reduction for the elderly should be based on individualized nutrition advice, although psychological factors, lifestyle factors and taste preference of the elderly also need to be considered.

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SUMMARY

Large segments of the South African population are presently in the process of urbanization. It is estimated that by the year 2010, seventy percent of South Africa's population will be urbanized, affecting mainly the Black population.

Progressive urbanization is associated with the Nutrition Transition characterized by a change from the traditional diet to the Westernized diet. This shift is accompanied by an increase in the proportion of people consuming the type of diet associated with a number of chronic diseases, such as hypertension.

Although hypertension cannot be linked to a certain segment of the population, the Black population, the male gender and the elderly, have enhanced susceptibility to hypertension. In spite of this, studies indicate that even among youths, lowered sodium intake is being proposed in the hope that it may decrease the risk of hypertensive disease later in life.

Food preparation and the use of commercially prepared foods are the areas in which sodium levels can be altered to reduce sodium intake.

Individuals following salt restricted diets have difficulty in complying with the diet, because sodium restricted diets are considered bland and tasteless.

Thus, a study investigating the acceptability of food, primarily home-prepared products, low in sodium, was considered necessary, in order to make recommendations that can improve the compliance of patients requiring sodium-restriction.

The purpose of the study was to assess the magnitude of sodium reduction that can be made, without significantly changing the perception of saltiness or decreasing the acceptability of a range of home-prepared food items.

A representative sample of the urbanized White and Black population of the Free State (N=58) were included, with age and race as precursors. Difference in salt perception and acceptability of food over three ranges of sodium concentrations (full recipe; approximately one third and approximately two third sodium reduction) were determined. Sodium content was estimated using the "MRC Food Composition Tables" and the "Nutritional content of age A (13% fat) beef carcase tables". Sodium content was validated using chemical analysis.

Affective (preference and acceptance) sensory tests were applied to measure salt perception and acceptability of four dishes varying in terms of sodium concentration, texture and complexity. Salt perception was rated using a numerical ranking line scale and acceptability was evaluated according to a nine-point Hedonic scale. Every sample was evaluated twice and the results of the initial and second sample showed a significant correlation. Samples were coded by means of three digital codes, in order to eliminate any assumption in respect of the order of the samples represented.

Because the same subjects were used at each of the twelve level combinations, it precluded the use of the standard three-way factor ANOVA and necessitated a three-way repeated measured ANOVA, which was performed with the aid of both BMDP and SAS packages. Paired difference t-tests were applied to determine the significance of differences.

The results indicate that sodium levels can be reduced by thirty percent without significantly reducing acceptability. Food/dishes with a smooth texture and complex nature and coarse texture with either simple or complex nature were found to be more acceptable than simple dishes with a smooth texture.

It can be concluded that sodium content can be reduced by one third without significantly decreasing the acceptability of a broad range of home-prepared food items. It is, however, necessary to consider salt interaction with sensory components and media in which sodium is presented, when making recommendations regarding sodium restriction.

OPSOMMING

Groot gedeeltes van die Suid-Afrikaanse bevolking is huidiglik in die proses van verstedeliking. Daar word beraam dat in die jaar 2010, sewentig persent van Suid-Afrika se populasie verstedelik sal wees, rakende hoofsaaklik die Swart bevolking.

Progressiewe verstedeliking word geassosieer met 'n verandering in dieetpatrone (Nutrition Transition). Hierdie verandering word gekenmerk deur die oorgang van 'n tradisionele dieet na 'n deels verwesterde lewenstyl en dieet. Hierdie dieetverskuiwings word weerspieël in die groot populasie verbruikers wat 'n dieet volg wat geassosieer kan word met 'n aantal chroniese siektes, byvoorbeeld hipertensie.

Alhoewel hipertensie nie gekoppel kan word aan 'n spesifieke populasie segment nie, affekteer dit meer ernstig die Swart bevolking, die manlike geslag en die bejaarde. Ten spyte hiervan, dui studies daarop dat 'n verlaagde natrium inname selfs onder die jeug, aanbeveel word, in die hoop om die risiko van die ontwikkeling van hipertensie op 'n latere ouderdom te verlaag.

Voedsel voorbereiding sowel as die gebruik van kommersieel-vervaardigde voedsels is die areas waar natrium vlakke verander kan word om die algemene natrium inname te verlaag.

Natrium verlaagde diëte word egter swak nagevolg. Die rede blyk te wees dat individue hierdie diëte as smaakloos ervaar.

Gevolglik is 'n studie ten opsigte van die aanvaarbaarheid van voedsel, hoofsaaklik tuis-bereide produkte, laag in natrium, nodig geag, sodat aanbevelings gemaak kan word met betrekking tot die verbetering van gereg-aanvaarbaarheid by die pasiënt wat 'n natrium beprekte dieet volg.

Die doel van die studie was om te bepaal tot watter mate die sout inhoud van voedsel verlaag kan word, sonder om 'n betekenisvolle verandering in die sout persepsie en aanvaarbaarheid van 'n reeks tuis-bereide voedsels, te veroorsaak.

Die steekproeftrekking weerspieël 'n verteenwoordigende groep van die stedelike Blank en Swart populasie in die Vrystaat (N = 58), met ouderdom en ras as voorspellers. Die verskil in sout persepsie en aanvaarbaarheid van voedsel in drie natrium konsentrasies (normale natrium inhoud; ongeveer een derde natrium verlaging en ongeveer twee derde natrium verlaging) is vasgestel. Die natrium inhoud van vier geregte is bepaal met behulp van die "MRC Food Composition Table", en die "Nutritional content of age A (13% fat) beef carcase tables". Die natrium-inhoud is bevestig met behulp van chemiese analise.

Affektiewe (voorkeur en aanvaardings) toetse is gebruik sodat die vier geregte, in verskillende natrium konsentrasies, ge-evalueer kon word volgens sout persepsie en aanvaarbaarheid. Sout persepsie is aangedui op numeriese rangskikking skale (lyn skaal) en aanvaarbaarheid is ge-evalueer met behulp van 'n nege punt Hedoniese skaal. Elke monster is twee keer ge-evalueer en die resultate van die eerste en tweede monster toon 'n beduidende korrelasie. Om enige aannames ten opsigte van die mees geskikte monster uit te skakel, is drie-syfer kodes vir die kodering van monsters gebruik.

Die gebruik van dieselfde proefpersone vir elk van die twaalf vlakke van kombinasie het die gebruik van die standaard drie-rigting Analise van Variansie uitgesluit en 'n herhaalde metings/faktore ANAVA genoodsaak. Dit is uitgevoer met behulp van BMDP en SAS pakette. Gepaarde t-toetse is aangewend om te toets vir beduidende verskille tussen die gemiddeldes.

Die resultate dui daarop dat natrium-vlakke met dertig persent verlaag kan word sonder om die aanvaarbaarheid noemenswaardig te verminder. Saamgestelde geregte met 'n gladde tekstuur, en eenvoudige- of saamgestelde geregte met 'n growwe tekstuur is meer aanvaarbaar gevind as eenvoudige geregte met 'n gladde tektuur.

Opsommend uit hierdie studie blyk dit dat die natrium inhoud van geregte met een derde verminder kan word sonder om die aanvaarbaarheid van 'n wye reeks voedsels berei vanaf huishoudelike resepte (tuisbereide voedsels) te verminder. Dit is egter nodig om die sout-interaksie met ander sensoriese komponente, sowel as die media waarin die natrium voorkom, in aanmerking te neem wanneer aanbevelings ten opsigte van natrium beperkings gemaak word.

APPENDICES

APPENDIX A:
KEY STRATEGIES TO REDUCE SALT AND SODIUM INTAKE

Key strategies summarized by Kapoor (1995:192); Robinson et al., (1989:142); Whitney and Rolfes, (1999:379), that can be employed to meet the request for food with less salt or sodium.

- Omit the salt in recipes if possible, reduce the salt in dishes gradually and over time as demand warrants.
- Add salt-free flavour the dishes with fruit juices, freshly prepared stocks, oils, wines, beers, spirits, flavor extracts, herbs and spices, or a combination of these ingredients in marinades and sauces.
- Experiment with the effects of herbs and spices to learn which ones will replace salt in recipes, but for a start, try chives, tarragon, parsley, or basil with vegetable selections and thyme, oregano, sage, or rosemaryn with meat dishes. As a general rule, limit the total quantity of dried herbs and spices to one to three teaspoons per 24 portions.
- Reduce the need for salt by heightening the natural flavors in dishes with sour ingredients like lemon juice, vinegar, angostura bitters, or citrus zests.
- Offer salt substitutes, half salt, or light salt only on guests' special requests. Do not use in food preparation.
- Replace salted foods like potato chips, crackers and nuts with unsalted forms when offering as snacks or using as coatings, toppings and extenders for meat, fish, poultry and vegetable dishes. Keep in mind, items can be high in sodium without tasting salty.

- When adding small amounts of salted or high sodium ingredients like salted peanuts or bacon to dishes, make their flavor pronounced by cutting into small pieces and sprinkling over the tops of dishes.
- In the case of yeast-leavened products where salt retards fermentation, include salt, but limit it to 1 teaspoon per loaf.
- Sodium free baking powder produced in house is another option.
- Prepare dishes from whole, unprocessed ingredients rather than processed ones with sodium containing additives such as MSG (Monosodium glutamate).
- Reduce the salt in cakes and quick breads by half and replace their baking powder with eggs, a commercial low sodium baking powder, or one prepared in house. Avoid self-raising flour; it contains salt and baking powder and therefore in high in sodium. (One egg has the leavening power of about 0.5 ml baking powder).
- Avoid highly salted foods and remove the saltshaker from the table
- Cook with only small amounts of added salt.
- Prepare food with sodium-free spices such as basil, bay leaves, curry, garlic, ginger, lemon, mint, oregano, pepper, rosemary, and thyme.
- Add little or no salt at the table; taste food before adding salt.

APPENDIX B:

NUTRITION LABELING REGULATIONS (Kapoor, 1995).

Salt free – less than 5 milligrams per standardized serving.

No salt added and unsalted – if (1) no salt is added during processing;
(2) salt is normally added during processing; and
(3) the statement "not a sodium-free food" is stated on the information panel.

Sodium free – less than 5 milligrams per standardized serving.

Very low sodium – contains 35 milligrams or less per standardized serving.

Low sodium – 140 milligrams or less per standardized serving.

Reduced or less sodium – contains 25% less sodium than the regular food.

The claim cannot be made if the "regular" food already meets the requirement for a "low" claim.

Light or lite – 140 milligrams or less per standardized serving or 50% per standardized serving as compared to the regular food if the food also meets the definition for "low" in calories and fat.

In the event the sodium is reduced 50% in a food but is now low in fat and calories, the label must state "light in sodium".

APPENDIX C:

STEP-BY-STEP INSTRUCTIONS FOR SETTING UP RANKING, RATING AND HEDONIC TESTS (Lawless and Heymann, 1998:99, 100).

- Prepare master sheet (see Appendix D).
- Fill in sample identification at top.

  In the example, in Appendix D for a study of fish, this may be scrod, cod, tuna, hake. Only the researchers should know the identity of the products or samples.
- Fill in judge numbers (i.e., 1, 2, 3, …). Assign each judge a number, and make sure that a key to these numbers is placed in the study notebook. It is simpler if a specific judge retains that number throughout the study.
- Assign three-digit random code numbers to each sample for each judge. Start from any point on the table of random numbers and use three digits for each number. Never use numbers that may have meaning to the judges (i.e., 013, 666, 911).

  Write the random numbers on the master sheet, one for each sample for each judge (use blue or black pen; numbers are indicated in *italics* in Appendix D). An occasional duplicate of a number may be found on a random-number table. If so, skip the duplicate number.
- Determine order of sample presentation, using a table of random permutations; numbers are read from top to bottom within a column. Use only numbers corresponding to the number of samples being tested (i.e., for four samples, use only numbers 1, 2, 3, and 4; read the numbers in the order they appear). Write the number (with a red pen; numbers are indicated in bold Appendix D) in the upper-right-hand corner of each square on the master sheet. This indicates the order in which each sample is presented to each judge. In the example, the first sample is served fourth, the second sample is served first, etc., for judge 1.
- Write the random codes on the sample containers. Use the random code numbers that are written on the master sheet. Code numbers on sample containers should match the appropriate code number on the master sheet. If

there are enough people working together, this can be done as random numbers are recorded on the master sheet.

- Prepare score sheet. Fill in the date, the judge number, and the random code numbers in the sequence in which the samples are to be evaluated (as indicated by random permutations).
- Prepare samples.
- Prepare an organized arrangement for portioning samples. A simple method is to make a master sheet template with sufficient space for the sample containers to be placed in the squares. This template may be made out of any large paper or available substitute. Allowing a 3-inc.(7.62 cm) square for each sample is suggested; however, this will vary depending on the sample container itself.
- Assemble sample containers on template. Once all the containers are placed on the template, it should be identical to the master sheet.
- Portion samples into containers.
- Assemble samples for each judge on a tray in the sequence that they are to be evaluated. Also, place the score sheet on the tray, with water for rinsing the palate. Double-check serving order.
- Serve samples to judges for evaluations.
- Decode score sheet on the master sheet. When judges are asked to rate only one attribute, a blank column is left between columns of random code numbers. When asked to rate more than one term, more blank columns (one column for each term rated) should be left. These columns provide space for recording judge scores after completion of the test. (Use a pen, never use pencil on master sheets or score sheets.) In this way, decoding is simple and orderly.
- Analyze the data.

APPENDIX D:

EXAMPLE OF A MASTER SHEET FOR A RATING, RANKING OR HEDONIC TEST (Lawless and Heymann, 1998:102)

JUDGE	SCROD	COD	TUNA	HAKE
1	*909* ^{4}	*623* ^{1}	*703* ^{3}	*903* ^{2}
2	*690* ^{3}	*558* ^{4}	*578* ^{1}	*383* ^{2}
3	*694* ^{2}	*373* ^{3}	*693* ^{1}	*290* ^{4}
4	*890* ^{1}	*763* ^{2}	*787* ^{3}	*661* ^{4}
etc..				

APPENDIX E:

QUESTIONNAIRE:

Thank you for being willing to complete this questionnaire and for your time to be part of the panel.

PLEASE CIRCLE THE APROPRIATE ANSWER:

1. Age:
   1. 17 – 30
   2. 31 – 50
   3. 50 +

   1

2. Gender:
   1. Male
   2. Female

   2

3. Ethnic:
   1. White
   2. Coloured
   3. Asian
   4. Black

   3

4. Do you do any food preparation ?
   1. Yes
   2. No

   4

If your answer is YES, answer question number five (5).

If your answer is NO, answer question number six (6).

5. During food preparation, how many salt do you add to the food?
   1. Only according to the recipe.
   2. More than the recipe.
   3. Less than the recipe.
   4. Add no salt.

   5

6. How often do you add salt to food at the table ?

1. Add no salt
2. Habitual, before you taste your food.
3. After you have tasted your food

6

7. Do you see yourself as a

1. High
2. Medium
3. Low salt user?

7

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APPENDIX E:

VRAELYS:

Dankie dat u bereid is om hierdie vraelys te voltooi en vir die tyd afgestaan om deel te vorm van die paneel.

OMKRING ASB. DIE TOEPASLIKE ANTWOORDE:

(Slegs vir kantoor gebruik.)

1. **Ouderdom:**
   1. 17 – 30
   2. 31 – 50
   3. 50 +

[ ] 1

2. **Geslag**
   1. Manlik
   2. Vroulik

[ ] 2

3. **Ras:**
   1. Blank
   2. Kleurling
   3. Asiaat
   4. Swart

[ ] 3

4. **Berei u self voedsel voor?**
   1. Ja
   2. Nee

[ ] 4

Indien u JA geantwoord het, beantwoord vraag nommer vyf (5).

Indien u NEE geantwoord het, beweeg na vraag nommer ses (6).

5. **Wanneer u voedsel voorberei, van hoeveel sout maak u gebruik?**
   1. Slegs volgens resep.
   2. Meer as resep.
   3. Minder as resep.
   4. Voeg geen sout by nie.

[ ] 5

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X

6. Hoe algemeen voeg u sout by voedsel, aan tafel ?

1. Voeg geen sout by nie.
2. Uit gewoonte, voordat aan voedsel geproe is.
3. Nadat eers aan voedsel geproe is.

☐ 6

7. Beskou u uself as 'n

1. Hoë
2. Medium
3. Lae sout gebruiker?

☐ 7

APPENDIX F:

EVALUATION FORM: ACCEPTABILITY

DATE: ____________ **PRODUCTS:** ____________

NAME and SURNAME: ____________ **TABLE NUMBER:** ____________

AGE: ____________

INSTRUCTIONS:

- You will receive three (3) samples.
- Before testing the sample: Purify your palette – rinse your mouth with the water, wait a few seconds and evaluate the sample.
- Purify your palette before and after each sample – rinse your mouth with the water, wait a few seconds and evaluate the sample.
  (The water and/or sample may be spit out in the spittoon provided.)
- Re-testing of the same sample is NOT permitted. Referring to the sample that you are busy with, as well as the previous samples.

Evaluate each sample and choose one term to describe you feeling towards the sample, the best.

PRODUCT GROUP ONE:

Sample number	Like extremely	Like very much.	Like mode-rately	Like slightly.	Neither like or dislike	Dislike slightly	Dislike mode-rately.	Dislik e very much.	Dislike extremely .

APPENDIX F:

EVALUERINGSVORM: AANVAARBAARHEID

DATUM: ______________ **PRODUK:** ______________

NAAM en VAN: ______________ **TAFEL NOMMER:** ______________

OUDERDOM: ______________

INSTRUKSIES:

- U word voorsien van drie (3) monsters.
- Voor u aan die monster proe: Suiwer u palet– spoel u mond uit met die water, wag 'n paar sekondes en proe die monster.
- Suiwer u palet voor en nadat u 'n monster evalueer, wag weer 'n paar sekondes en proe die volgende monster.
- Herhaal diè proses voor elke monster wat u evalueer.
- Die water en/of monster kan uitgespoeg word, in die spoegbakkies voorsien.
- Hertoets van die monster word NIE toegelaat NIE.
  Dit verwys nie net na die monster waarmee u besig is niem maar ook na die vorige monsters.

Evalueer elke monster en dui aan watter term beskryf u houding teenoor die monster die beste.

EERSTE GROEP MONSTERS:

Monster nommer	Hou uiters baie van	Hou baie van	Hou matig van	Hou slegs effens van	Neutraal: Nie sleg nie, nie lekker nie	Nie lekker nie	Hou nie van nie	Hou glad nie van nie	Onaan-vaardaar

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APPENDIX G:

EVALUATION FORM: SALT PERCEPTION

DATE: ____________________ **PRODUCT:** ____________________

NAME and SURNAME: ____________________ **TABLE NUMBER:** ____________________

AGE: ____________________

INSTRUCTIONS:

- You will receive three (3) samples.
- Before testing the sample: Purify your pallet – rinse your mouth with the water, wait a few seconds and evaluate the sample.
- Purify your palette before and after each sample – rinse your mouth with the water, wait a few seconds and evaluate the sample.
  (The water and/or sample may be spit out in the spittoon provided.)
- Re-testing of the same sample is NOT permitted.- referring to the sample that you are busy with, as well as the previous samples.

Evaluate each sample. Give an indication of the saltiness of the sample and allocate a score between one (1) and five (5) , where :

1=Taste less (not salty at all.)
2=Salty, but unpalatable
3=Salty, no need for additionally salt.
4=Very salty.
5=Too salty, no longer tasty.

1= Tastless (not salty at all)	3= Salty, on need for adding salt	5= Too salty, no longer tasty

PRODUCT GROUP ONE:

Sample number:	Saltiness. (0 to 5.)

APPENDIX G:

EVALUERINGSVORM: SOUT PERSEPSIE

DATUM: ____________________ **PRODUK:** ______________

NAAM en VAN: ____________________ **TAFEL NOMMER:** ______________

OUDERDOM: ____________________

INSTRUKSIES

- U word voorsien van drie (3) monsters.
- Voor u aan die monster proe: Suiwer u palet– spoel u mond uit met die water, wag 'n paar sekondes en proe die monster.
- Suiwer u palet voor en nadat u 'n monster evalueer, wag weer 'n paar sekondes en proe die volgende monster.
  Herhaal diè proses voor elke monster wat u evalueer.
- Die water en/of monster kan uitgespoeg word, in die spoegbakkies voorsien.
- Hertoets van die monster word NIE toegelaat NIE.
  Dit verwys nie net na die monster waarmee u besig is niem maar ook na die vorige monsters.

Evalueer elke monster volgens die southeid/soutpersepsie, deur elke keer 'n punte toekenning te maak tussen een (1) en vyf (5), waar:

1=Laf (glad nie sout nie.)

2=Sout, maar onsmaaklik.

3=Sout, sou geen ekstra sout wou byvoeg nie.

4=Baie sout.

5=Te sout, nie meer lekker nie.

1= Laf (glad nie sout nie)	3= Sout, sou geen ekstra sout wou byvoeg nie.	5= Te sout, nie meer lekker nie

EERSTE GROEP MONSTERS:

Monster nommer:	Southeid/ Soutpersepsie. (een tot vyf.)

APPENDIX H:

SIMPLE DISH WITH SMOOTH TEXTURE

MASHED POTATOES (Adapted from Human, 1990: 117)

Ingredients:

750 g	Potatoes
16.8 g	Butter
1.8 g	Salt
33.6 g	Parsley
125 ml	Milk

Method:

1. Wash, scrub, and peel the potatoes, and boil until cooked in a little water.
2. Drain, and mash immediately with a fork.
3. Add butter, the milk and salt to taste. Beat until light. Mashed potato should not be too dry, nor should it be too moist.
4. Reheat thoroughly, sprinkle with parsley.

APPENDIX I:

SIMPLE DISH WITH COARSE TEXTURE

PORRIDGE (KRUMMEL PAP) (Adapted from Human, 1990: 223)

Ingredients:

375 ml	Water
5 ml	Salt
500 ml	Mealie meal

Method:

1. Add the salt to the boiling water in a saucepan.
   Add the mealie meal slowly, so that it piles up, with the water boiling round it. Do not stir.
2. Cover and simmer for 10 to 15 minutes.
3. Stir with a fork until crumbly and continue cooking over low heat. The porridge should be crumbly.

APPENDIX J:

COMPLEX DISH WITH SMOOTH TEXTURE

VEGETABLE SOUP (Adapted from Human, 1990: 68)

Ingredients:

125 g	Onion, sliced
60 g	Butter
50 ml	Diced carrots
50 ml	Chopped celery
125 g	Potato, diced
125 g	Turnip, diced
375 g	Tomatoes, skinned and sliced
1 L	Water
10 ml	Salt
1 ml	Pepper
12,5 ml	Finely chopped parsley

Method:

1. Brown the onion lightly in the butter, add the rest of the vegetables, except the tomatoes and parsley, and saute for a further 10 minutes.
2. Add the tomatoes and water and simmer until tender.

   Add water if it boils away.
3. Add the salt, pepper and parsley. Bring to boil and serve hot.

APPENDIX K:

COMPLEX DISH WITH COARSE TEXTURE

BEEF STEW (Adapted from Human, 1990: 116)

Ingredients:

1 kg	Beef without bone, cut into 10-mm cubes
125 g	Onion, sliced
12,5 ml	Oil
10 ml	Salt
1 ml	Pepper
1	Bayleaf
1 ml	Dried thyme
1 L	Boiling water
200 g	Carrots, cut into cubes
375 g	Potatoes, cut into cubes
125 g	Small onions
15 ml	Flour
50 ml	Cold water

Method:

1. Brown the meat and onion in the hot oil in a heavy saucepan.
2. Add the seasoning and 750 ml boiling water, simmer for 1 to 2 hours, or until the meat is tender.
3. Add the vegetables and the remaining 250 ml boiling water. Simmer for a further half hour.
4. Mix the flour and the cold water to a paste and stir into the stew to thicken the gravy. Cook for a few minutes.