THE NUTRITIONAL QUALITY OF TRADITIONAL AND MODIFIED TRADITIONAL FOODS IN KWAZULU-NATAL

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ABSTRACT

The role of traditional foods in reducing hunger and malnutrition is not well documented in South Africa. The aim of this study was to investigate the distribution, popularity and nutritional value of traditional foods in KwaZulu-Natal through evaluation of recipes submitted for a traditional foods recipe competition. Traditional recipes are characterised by indigenous or local ingredients passed from one person to another over many generations, with little or no change in form. Modern recipes include those which use processed ingredients. Modified recipes include a mixture of traditional and modern ingredients. The differences between the ingredients of traditional, modern and modified recipes were investigated to determine how modifying and modernising traditional foods changed their nutritional quality. Using competition entries from a traditional recipe competition from all 11 districts of KwaZulu-Natal, the nutritional value of 1200 recipes was analysed using published Food Composition Tables. The 10 most commonly submitted recipes were identified. The majority of recipes came from the more rural districts of KwaZulu-Natal. The largest number of recipes submitted were traditional (68% of entries) followed, respectively, by modified (24%) and modern (8 %) recipes. Adult females submitted more recipes than female youths, male youths and adult males. In general, modified foods had higher nutrient contents than traditional and modern foods. There was a negative correlation between food popularity and nutrient content, suggesting that popular foods were not necessarily the most nutritious. It was concluded that the people of KwaZulu-Natal simultaneously use traditional, modified and modern recipes, but that there is a shift towards food modification through use of non-indigenous crops and modern ingredients. Further investigations into the relationship between food choice and the effect of modification on food quality attributes, including sensory and storage quality, are recommended.

DECLARATION

I, Minse Modi, declare that:

(i) The research reported in this mini-dissertation, except where otherwise indicated, is my original research.

(ii) This mini-dissertation has not been submitted for any degree or examination at any other university.

(iii) The data and findings of this study are confidential to the KwaZulu-Natal Department of Agriculture and Environmental Affairs until released by the Provincial Department and a full digital copy of the report, data and analysis is submitted, along with this work, to the Department.

(iii) This mini-dissertation does not contain another person's data, pictures, graphs or other information, unless specifically acknowledged as being sourced from such persons.

(iv) This mini-dissertation does not contain another author's writing, unless specifically acknowledged as being sourced from other authors. Where other sources have been quoted, then:

- their words have been re-written, but the general information attributed to them has been referenced
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(v) This mini-dissertation does not contain text, graphics or tables that are copied and pasted from the Internet, unless specifically acknowledged, and the source being detailed in the dissertation and the reference section.

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Minse Modi Date

As Research Supervisor, I agree to submission of this mini-dissertation.

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Professor SL Hendriks Date

As Research Co-supervisor, I agree to submission of this mini-dissertation.

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Mr M Siwela Date

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CHAPTER 1

THE PROBLEM AND ITS SETTING

1.1 Introduction

South Africa faces growing rural poverty, resulting in increased unemployment and urbanisation (Jansen van Rensburg *et al*, 2003). Lifestyle changes (i.e. food consumption and living standards) are linked to urbanisation (Flyman, 2007). There has been a shift of preference from traditional to industrially processed food, which has led to increased health problems in sub-Saharan Africa (Flyman, 2007). Modern society does not favour traditional crops resulting in loss of knowledge about these crops (Maundu, 1997). However, food insecurity and hunger in South Africa are likely to increase due to increasing food prices (Hendriks, 2005) and the availability of cheap, high energy but nutrient poor foods, such as those from fast food outlets, is having an impact on diets in South Africa (Caballero, 2005; Flyman, 2007).

Lack of knowledge about the nutritional value and preparation of traditional food has resulted in their neglect (Altieri, 1987). Traditional rural communities were reported to be nutritionally secure, even in times of drought, because they used wild edible plants (Altieri, 1987). Therefore, traditional foods could make an important contribution to the alleviation of food insecurity in sub-Saharan Africa. Traditional foods should be given the same attention with respect to promoting their consumption as conventional foods because the former also have good nutritional value (Mnzava, 1997). Traditional vegetable crops could make a significant contribution to food security in KwaZulu-Natal and other provinces of South Africa (Jansen van Rensburg *et al*., 2003).

KwaZulu-Natal is one of the few provinces in South Africa with a low human development index (Mtshali, 2002). Rural households in KwaZulu-Natal have been reported to be predominantly female and poor (Mtshali, 2002). Unemployment and lack of resources for agricultural production (e.g. land, capital, appropriate technology, inputs and training) are some of the major problems that affect the province's rural areas. Traditional foods are generally derived from traditional crops and wild edible plants and are likely to be more accessible to rural communities than modern foods. However, there is not sufficient information about the nutritional value of the traditional foods of KwaZulu-Natal, or how modifications and adjustments to recipes change the nutritional quality of foods.

1.2 Research problem

The aim of this study was to determine the nutritional quality of the recipes submitted for a traditional food recipe competition.

1.2.1 Sub-problems

Sub-problem1: What recipe types submitted can be classified as traditional, modern and modified?

Sub-problem 2: What were the most popular recipes submitted?

Sub-problem 3: How did modification affect the nutritional quality of recipes?

1.3 Conceptual framework for categorisation of recipes

Recipes were categorised according to whether they were traditional, modified or modern. The assumption was that most recipes would be comprised of plant ingredients. Therefore, the crops or plants used to make the recipes were classified as wild crop, non-indigenous wild, traditional indigenous, traditional non-indigenous and conventional. Indigenous wild crops were defined as wild edible plants that originate from Africa (e.g. *Spiny emex* and *Amaranthus thurnbergii*) (Fox & Norwood Young, 1982). Non-indigenous wild plants were classified as edible plants that have been introduced from countries outside Africa (e.g. blackjack and goose foot) (Fox & Norwood Young, 1982). Both wild and non-indigenous crops are generally considered as weeds infecting cultivated lands (Grabandt, 1985). These (weeds) constitute wild leafy vegetables (Modi, 2004). Traditional indigenous crops are cultivated crops that originate from Africa (e.g. sorghum and cowpea) (Fox & Norwood Young, 1982). Non-indigenous traditional crops are those that are cultivated by both traditional and commercial farmers, but which traditional farmers treat as part of their cultural practices (e.g. maize, beans). Conventional crops are cultivated crops that were introduced from countries outside Africa, mainly by Europeans from Portugal, the Netherlands and Britain (Thompson, 2000). In the context of this study, conventional crops are classified as those that are generally not grown by resource-poor subsistence or small holder farmers (e.g. wheat, rice, cucumber).

To establish a relationship between recipe types and the crops used to make them, a conceptual correlation was designed and is presented in Table 1.1.

Table 1.1 Conceptual relationships among different crops that contribute to traditional, modified and modern foods

	Wild indigenous crops	**Wild non-indigenous crops**	**Traditional indigenous crops**	**Traditional non-indigenous crops**	**Conventional crops**
Wild indigenous crops	Traditional	Traditional	Traditional	Traditional	Traditional
Wild non-indigenous crops	Traditional	Traditional	Traditional	Traditional	Modified
Traditional indigenous crops	Traditional	Traditional	Traditional	Traditional	Traditional
Traditional non-indigenous crops	Traditional	Traditional	Traditional	Modified	Modified
Conventional crops	Traditional	Traditional	Traditional	Modified	Modern

A recipe made of a combination of wild plants was defined as being traditional, regardless of whether the crops were indigenous or non-indigenous. The same applied to a combination of traditional and wild crops that were classified as traditional (Table 1.1).

1.4 Study limits

The data were collected from a traditional foods recipe competition and participants were not informed about what might change traditional food to modified or modern food. There were no direct or probing questions to the participants in the questionnaires. The participants could have a bias for recipes they perceived as “traditional”. It was difficult for the KwaZulu-Natal Department of Agriculture and Environmental Affairs to make sure that everyone knew about the competition. Therefore, it is likely that the short notice about the competition affected the sample size and demographics, with respect to the age, status and gender of participants, as well as other factors. The number of questions in the questionnaire was too limited to collect data on a wide range of aspects relating to traditional foods, and in some instances questions were not clear. In addition, nutritional analysis using secondary data has limitations associated with the variety of methods of laboratory chemical analyses used by the original publishers, the age of plants at the time of analysis, the effect of environment (e.g. soil fertility) on the plants during growth and the time of the year when the plants were grown or harvested, among others.

1.5 Definition of terms

The KwaZulu-Natal Department of Agriculture and Environmental Affairs undertook the competition from which data for this study, to identify popular traditional recipes in the province, were derived. Since the objective of this study was to provide a critical analysis of the recipes for the Department with a view to identifying their differences, it became clear that new terminology to describe recipe types was necessary. To avoid confusion in the description of the recipes, it was necessary to define the terms commonly used in this study.

Traditional food: recipes that are used locally and have been passed from one generation to the next. Crops, plants or meat used as ingredients may be indigenous wild only, indigenous conventional only, introduced (non-indigenous) wild only, introduced conventional only, or a mixture of all these categories. Common basic ingredients can differentiate between traditional and non-traditional foods. For example, to make steamed bread (*ujeqe*) the common ingredients used are: flour, sugar, salt and yeast. The addition of other ingredients (e.g. spices) would result in a modified product. In this study the term "traditional" is associated with black Africans living in rural areas.

Modified food: foods made from basic traditional food ingredients with the addition or replacement of ingredients with modern ingredients (e.g. spinach used instead of wild leafy vegetables to make *isijabane* or addition of spices).

Modern food: fashionable food derived from crops that are not widely grown by rural households, and from processed ingredients that require commercial production. Modern foods are characterised by ingredients that are not typically used by rural inhabitants and are often processed foods. A modern food does not contain any wild and indigenous plants, which means that it is made of conventional commercial ingredients only.

1.6 Study assumptions

The following assumptions were made in this study:

- Since traditional, indigenous and wild crops and vegetables grow mainly during the cropping season (summer) in KwaZulu-Natal, and the traditional food recipe competition was conducted in the summer, there was no limitation on the availability of these crops as their availability was not affected by the time of year
- The nutritional value of food plants reported in the literature is accurate
- People decided to participate in the competition not only for the prize money, but as they were also interested in traditional food and valued local dishes
- Rural people understand what is meant by a 'traditional' food.

1.7 Organisational structure of the mini-dissertation

Traditional food recipes were submitted by participants in a competition conducted by the KwaZulu-Natal Department of Agriculture and Environmental Affairs. Chapter 1 presents background information to the study and the conceptual framework that leads to the statement of the problem. The key terminology used in this study is explained in Chapter 1. Chapter 2 presents a review of the literature. Chapter 3 explains the methodology used to collate the data submitted by participants; determines nutrient values of the recipes and explains how data management and analysis were performed. Results and discussions are presented in Chapter 4 in accordance with the stated sub-problems. Conclusions and recommendations are presented in Chapter 5.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Before the era of organised agriculture, people obtained food by hunting wild animals and gathering food from plants in natural environments (Harlan, 1992). The process of plant domestication led to some plants and animals being allowed to increase in numbers, while less sought after species were not protected (Harlan, 1992; Fox & Norwood Young, 1982). As human societies evolved, they increasingly relied on fewer crop species with each passing era (Harlan, 1992). Presently, humans rely principally on about 30 food crops among thousands with potential as food sources (Harlan, 1992; Loomis & Connor, 1996).

As agriculture developed, special techniques of sowing, weeding, irrigating and fertilising crops developed to provide greater quantities of food for growing populations. These techniques were suitable for a handful of crops that now dominate commercial agriculture (Knauft & Gardner, 1998). Commercial agriculture has negatively affected the value of traditional crops, which were typically produced by small-scale subsistence farmers (Harlan, 1992; Higgins & Chrispeels, 2003). With time, it is likely that knowledge about traditional crops will be lost due to the lack of documented information about their cultivation, food preparation and nutritional values.

The objective of this chapter is to present a review of current knowledge about traditional crops in South Africa, with a special focus on Zulu foods. The basis of the argument for this chapter is that traditional South African crops play a major role in traditional food systems, but have been neglected in modern diets. It is further argued that a decline in the use of traditional crops by rural dwellers in sub-Saharan Africa is associated with poor diets, resulting in nutrient deficiencies and diseases (Kwapata & Maliro, 1995). Although data are available on the nutritional value of some traditional plants (Flyman, 2007; Kruger *et al*, 1998; Love *et al*, 2001), available literature on the role of traditional crops in the South African context is mostly limited to small community qualitative surveys

(Bichard *et al.*, 2005; Jansen van Rensburg *et al.*, 2004; Mbenyane *et al.*, 2005; Nesamvuni *et al*., 2001). Lessons from other African countries are used to strengthen the argument about the potential role of traditional crops in food security. To explain the factors that influence preference for traditional food, lessons from studies about food preferences in general are used (Peter *et al*., 2001; Senauer *et al*., 1991). The chapter concludes with a broad identification of knowledge gaps regarding the role for traditional food in food security.

2.2 South African food culture

2.2.1 An historical perspective of food culture in KwaZulu-Natal

The history of South Africa shows that Bantus (indigenous African people in South Africa) moved south of the Limpopo River about 1500 years ago (Thompson, 2000). The Bantus were primarily nomadic farmers who combined knowledge of cattle keeping and slash-and-burn cultivation with expertise in metalwork. The southward movement involved a moving frontier of farmers seeking new fields and pastures, who interacted with pastoralists and hunter-gatherers (the Koi-koi and San people) (Thompson, 2000). The farmers settled throughout southern Africa, east of the 400-millimeter rainfall line (along the Drakensberg mountains) and as far as the south western limits of cropping along the Great Kei River (Thompson, 2000).

The Bantu farmers chose to minimise the risk of crop failure rather than maximise production (Thompson, 2000). These farmers kept large herds of cattle and associated great material and symbolic value with these animals. Cattle were valued for their milk and hides, but were seldom slaughtered for meat, except for ceremonial occasions. Hunting game provided meat, a major source of protein, while additional supplies came from domesticated goats and sheep. The Bantu farmers also cultivated a range of indigenous (originating in Africa, including areas where Bantus had emigrated) crops, including millet, sorghum, beans, and melons, along with other grains and vegetables. Those farmers who settled close to the sea fished and collected shellfish. By using a range of food sources, the farmers spread the risks of food insecurity in an ecological system that was constantly subject to drought, disease, and crop failure.

Traditional vegetables used by the Bantus in rural areas of South Africa were derived mainly from wild edible plants (Fox & Norwood Young, 1982). These wild plants were a significant source of nutrients before the introduction of conventional vegetables by Europeans (Fox & Norwood Young, 1982). The introduction of new crops and foods by Europeans, and new techniques for growing these crops, resulted in a change of diet (Fox & Norwood Young, 1982; Thompson, 2000). The introduction of white-owned trading stores with attractive food items, such as processed fats and spices, meant that people had to find employment in order to afford food sold in trading stores (Callinicos, 2004; Fox & Norwood Young, 1982). The growing population and an increase in livestock resulted in people having to pay the taxes and levies imposed by chiefs (Callinicos, 2004). With time, it became impossible for the Bantus to provide enough food for their households without having to earn cash (Callinicos, 2004; Fox & Norwood Young, 1982; Thompson, 2000). The result of these changes was that people increasingly relied on purchased foods (Thompson, 2000). The reliance on processed foods is very likely to have led to traditional and indigenous foods being less predominant in indigenous people's diets. However, there may be many other factors that influenced the decline of traditional diets in the Bantu culture, such as improved knowledge about other food types and changing socioeconomic situations. In spite of western influence, there is evidence that indigenous people in rural areas have maintained elements of their traditional lifestyles, including traditional foods (Fox & Norwood Young, 1982). Published literature on how traditional diets have been modified through the influences of modernisation (introduction of exotic foods and associated changes in lifestyles affecting preferences) is not available.

2.2.2. Historical and contemporary Zulu traditional foods

As it is true for all indigenous peoples, Zulus make traditional food from cultivated crops and edible wild plants collected from cultivated fields and/or the veld (Modi, 2004) (refer to Table 2.1). Cultivated traditional crops typically include cereals, legumes and cucurbits (Modi, 2003). Historically, the most common legumes used by Zulus were cowpeas and groundnuts (Fox & Norwood Young, 1982). Popular cereals were bulrush millet, finger millet and sorghum (Fox & Norwood Young, 1982). Popular cucurbits were gourds, African melons (Figure 2.1) and pumpkins (Fox & Norwood Young, 1982). These crops were used to make a variety of traditional dishes. An example of a popular traditional dish in the Zulu culture is shown in Figure 2.2, and commonly used wild vegetables for preparing traditional food are shown in Figure 2.3.

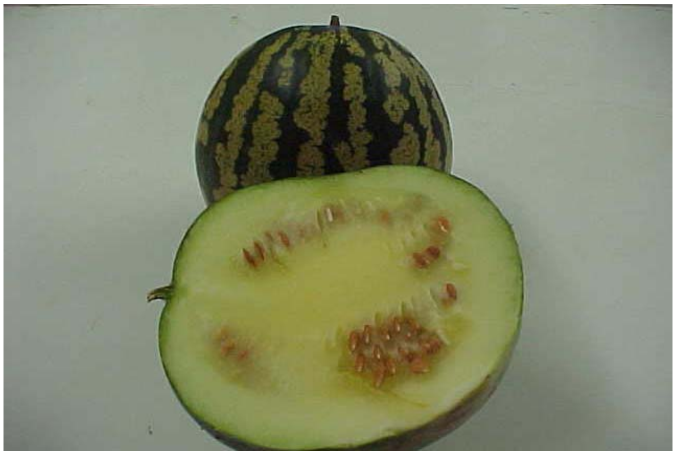

Figure 2.1 African melon, an indigenous cucurbit of South Africa (photo provided by Prof AT Modi, University of KwaZulu-Natal).

Figure 2.2 Four plates of *isijingi*, a Zulu traditional dish.

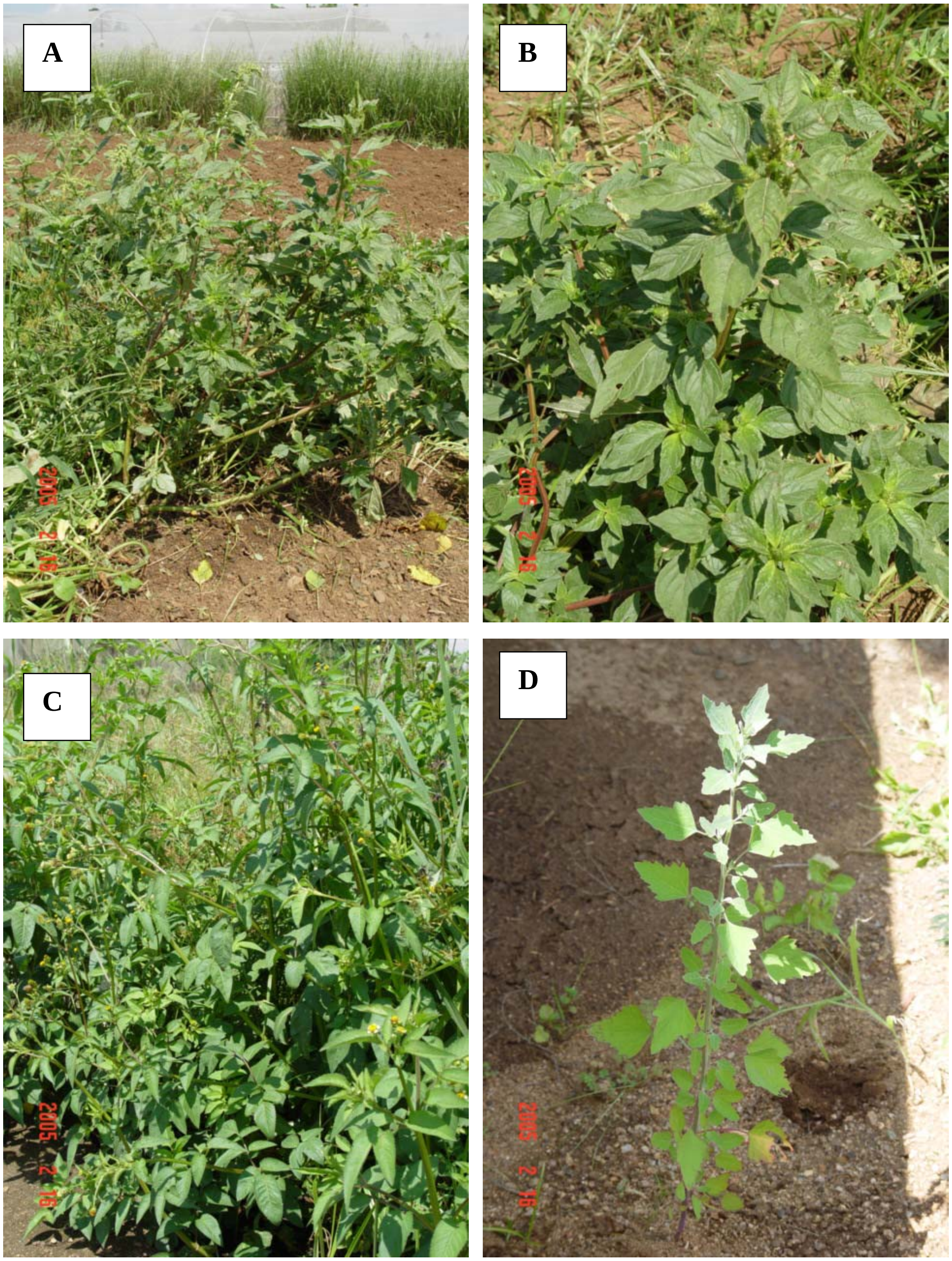

Figure 2.3. Commonly available wild vegetables used traditionally by Zulus and other ethnic groups in South Africa, including different *amaranthus* species (A and B), black jack (C) and lamb's quarters (D) (photos provided by Kathy Arbuckle, University of KwaZulu-Natal).

Table 2.1 Some popular Zulu traditional foods

Traditional food name and brief description about preparation
Umcaba- is prepared from fermented milk (*amasi*) and maize or sorghum. Maize or sorghum is boiled, pounded and then mixed with fermented milk. The mixture is allowed to stand for a while before being eaten (Nyembezi, 1966).
Isijingi- is made from crushed maize mixed with pumpkin (figure 2.2). The pumpkin is boiled soft before maize meal is added. The mixture is cooked for a few minutes before serving warm (Nyembezi, 1966).
Ujeqe -Bread made by boiling crushed green maize or sorghum. Green maize is crushed to make dough. The dough is raised by adding a small amount of traditional beer to it. The dough is then covered in maize husks and steamed in water until it is ripe (Nyembezi, 1966).
Isijabane- is prepared in a similar way to *isijingi*, except that wild vegetables (those vegetables that grow without cultivation in the wild, or as weeds of cultivated crops e.g. blackjack, *amaranthus*; Figure 2.3) replace pumpkin (Bat and Rubuluza, 2002; Nyembezi, 1966).
Umbhaqanga- a thick porridge made from crushed maize or sorghum and beans (Nyembezi, 1966). Beans are cooked until soft. Crushed maize and salt are then added to cooked beans and the mixture simmers while being stirred occasionally until maize is soft.
Izinkobe- boiled maize grain. Maize grains can be fresh or dry.
Izinkobe zikabhontshisi- Maize grains are partially cooked. Beans and salt are added to the maize and the mixture is cooked further until it is soft, with a significant amount of liquid occurring as thick soup from dissolved beans (Nyembezi, 1966).
Umxhafele a mixture of *izinkobe* and cooked wild vegetables or pumpkin leaves (Nyembezi, 1966). Salt is added.
Isiqhadala- a mixture of cooked maize flour and beans or cowpeas or bambara groundnuts (Nyembezi, 1966).
Isitambo- is made from stamped dry maize cooked with or without beans (Nyembezi, 1966). To make stamped maize (samp), dry maize grains are stamped (crushed into large pieces, while removing the seed coat) on a wooden stamping block.
Amahewu- maize meal is cooked to make porridge. Cool porridge is fermented overnight before it is ready for serving (Nyembezi, 1966).
Ugume or **ukhothe-** roasted maize powder that is eaten as a traditional snack. *Ugume* can be stored in an airtight glass container for up to a year (Nyembezi, 1966).
Idokwe- porridge made from maize or sorghum flour and served warm. The flour can be fermented in warm water overnight and cooked sour before it is served warm. Sugar may be added. (Nyembezi, 1966).

Meat has always been an important food for the Zulus, but it is mainly consumed on special traditional occasions or to show a sense of hospitality in welcoming guests. During such occasions, neighbours would be invited to join in a feast (Sosibo & Harvey, 2000). Beef, goat and chicken are common domestic sources of meat for Zulus (Sosibo & Harvey, 2000).

Food still holds an important cultural significance in Zulu communities. However, the Indian and European cultures may have influenced Zulu food, so that it is modified by the inclusion of non-traditional food items (Sosibo & Harvey, 2000). Currently, traditional food is cooked mainly for special occasions and there is more emphasis on specific traditional dishes (Sosibo & Harvey 2000), such as the ones shown in Table 2.1. Contemporary Zulu food is sometimes mentioned in government information pamphlets and Internet pages to expose prospective tourists to an important feature of South African culture (Anon, 2005). The ingredients of the advertised Zulu dishes include many ingredients that were not traditionally part of the Zulu diet, such as spices and cooking oils (Anon, 2005). Disuse of some traditional ingredients, such as traditional and wild plants, may be due to unavailability, lack of knowledge (e.g., of nutritional value, cooking guidelines, etc.) and pressure to comply with modern preferences for food tastes (e.g. saltiness) (Drewnowski & Holden-Wiltse, 1992).

Despite the rich food culture of Zulu people (Nyembezi, 1966, Sosibo & Harvey, 2000) and interest in it (Anon., 2005) there has been no attempt to quantify the nutritional value of traditional Zulu dishes. Even contemporary South African nutrition data (Kruger *et al*., 1998; Love *et al*., 2001) bears no evidence of studies on indigenous food dishes. There is little literature published on the nutritional value of traditional dishes in South Africa, apart from information on specific ingredients published by Kruger *et al*. (1998). Flyman (2007) and Nesamvuni *et al*. (2001) investigated the nutritional value of wild leafy vegetables consumed by Tswana and Venda people, respectively, but no data on traditional dishes were presented. In recent studies, Modi *et al.* (2006) and Mbenyane *et al.* (2005) argued that there may be a decline in knowledge of indigenous foods. Modi (2004) has suggested that wild vegetables are comparable or better than conventional vegetables with regard to some nutrients, and Mbenyane *et al.* (2005) have argued that there is a need for investigations into the nutrient status of indigenous foods, in order to promote their consumption in South Africa.

2.3 Possible factors influencing traditional food value

A combination of agricultural development (that has promoted large scale production of a few crops using artificial inputs), and commercialisation (which has created food commodities), have influenced the way traditional foods are prepared (Higgins & Chrispeels, 2003). Lack of research on traditional food nutritional composition has been associated with scarcity of information about the value and cooking of traditional food (Fox & Norwood Young, 1982). Since there is generally little information about cooking of traditional food, it is likely that people will rely on modern cooking methods when preparing traditional foods. The reliance on modern preparation methods may have consequences for modifying traditional dishes and influencing the nutritional value of traditional crops. There may be many ways in which traditional food can be modified. In the next sub-section, only cooking and preservation are explored as possible factors that may influence the value of traditional foods, because these are relevant to this study.

2.3.1 Modern methods of cooking traditional foods

Some popular South African traditional foods are presented in Table 2.1, with brief explanations of the preparation methods used. Some methods mentioned in Table 2.1 are still practised, but evidence shows that traditional foods are modified by the addition of modern ingredients, such as exotic spices (Mathenge, 1997). Mixing traditional and exotic ingredients to change the original taste, smell and appearance of the traditional food, modernises the traditional food. Modernisation of traditional food is likely to differ from one community to another, because communities have different socioeconomic situations and exposure to commercial products. Communities may differ in the way they are subjected to modern influences, depending on the type of influence. For example, a community in the proximity of an urban area may interact with foreigners who use exotic ingredients and easily learn new food-related cultures, whereas a community far away from urban areas may learn about new food-related cultures mainly through the media and migrant labour. The type of food may also be important in whether and how much it will be modernised. Some dishes are more easily modified than others. For example, in Kenya, indigenous vegetables such as S*olanum nigrum* and the A*maranthus* species are eaten as a relish for cooked maize meal or rice, a modern commercial crop (Mathenge, 1997). People who do not like the bitter taste of some wild indigenous leafy vegetables mix the wild vegetables with mild tasting conventional vegetables, such as spinach (Mathenge, 1997).

Traditionally, boiling was the main method of cooking vegetables. However, long periods of cooking have a negative effect on the nutritional quality of vegetables (Jansen van Rensburg *et al.*, 2004). To preserve nutritional quality, wild vegetables can be cooked fresh or after sun-drying (Jansen van Rensburg *et al.*, 2004). Sometimes the leaves of wild vegetables are eaten raw, as is the case with the *Oxalis* species (Bhat & Rubuluza, 2002; Fox & Norwood Young, 1982). Some traditional vegetables need to be cooked for up to two hours (e.g. certain varieties of *taro*) while others are cooked for a few minutes (e.g. amaranthus) depending on the texture and the need to eliminate chemical compounds that cause unpleasant tastes (Jansen van Rensburg, *et al*., 2004). Quick preparation methods may be advantageous and preferred by people who are aware of the effects of boiling on vegetables' nutritional value, or those who may not wish to wait too long before eating. For example, Fox & Norwood Young (1982) reported that hungry and tired women returning from the field would quickly boil wild leaves in a little water and eat them. These cooked vegetables are referred to as *ilaxa* (pot herb) and are assumed by traditional women in the rural areas to be the most nutritious form of wild vegetables. *Ilaxa* is a common dish in the Eastern Cape (Fox & Norwood Young, 1982).

In South Africa, cooked wild leaves are sometimes used as a side dish or relish eaten with stiff porridge (Bhat & Rubuluza, 2002; Jansen van Rensburg *et al*., 2004). This method differs from the one explained for *isijabane* in section 2.2.2, where maize meal is added and stirred into green leaves as they start to boil, to obtain a stiff green porridge. However, both methods of preparation have been reported to allow similar retention of nutrients (Fox & Norwood Young, 1982). In modern times, traditional or wild leaves are mixed with fried (in cooking oil) onion and tomatoes and minced peanuts or peanut butter (Jansen van Rensburg *et al*., 2004; Kwapata & Maliro, 1995). It has been reported that steam blanching (with no addition of salt or other ingredients) followed by dehydration, is used to retain nutrients such as ascorbic acid in wild vegetables (Jansen van Rensburg *et al*., 2004).

A typical example of traditional food modernisation is steamed bread, a modified form of *ujeqe* (Table 2.1). Modern variations of steamed bread are made by mixing wheat flour (purchased), salt, sugar, yeast and water to make dough. Eggs and melted butter may also be added to the mixture (Peace Diaries, 2003). Baking powder (mainly sodium bicarbonate) is sometimes added as a leavenin agent.. The dough is left in a warm place to rise. When the dough has risen, it is wrapped with maize leaves (Table 2.1) and steamed for an hour (Peace Diaries, 2003). Also, baking soda may be added to soften vegetables. Baking soda may cause a decrease in vitamin content (particularly vitamin C and thiamin) due to their degradation, while sodium content may increase. Despite the significant modifications in steamed bread compared with *ujeqe*, with respect to the ingredients, steamed bread is still regarded as traditional bread, and is called *ujeqe* in Zulu.

It is likely that there are many traditional dishes that have been modified to suit the modern lifestyle, but whose Zulu names are still maintained. The modernisation of traditional foods may present a challenge to nutritionists, and food researchers in particular, when recommendations about the food value of traditional foods are required. Modern methods of cooking may modify the nutritional value of traditional food to the extent that a certain traditional food or dish may have different nutritional values, depending on who makes it and where they reside.

2.3.2 Preservation of vegetables

Traditional vegetables can be collected during seasons of abundance and preserved by sun-drying for later use during periods of food scarcity; when environmental conditions do not permit their availability (e.g. dry winter in South African rural areas) and when natural disasters destroy crops, as is common in sub-Saharan Africa (Jansen van Rensburg *et al*., 2004). Drying usually takes place towards the end of summer, when a wide variety of leafy vegetables is available (Fox & Norwood Young, 1982). Although drying is one technique to improve shelf life, drying can contaminate further foods with impurities (Jansen van Rensburg *et al*., 2004). Therefore, care should be taken when drying vegetables to avoid contamination. This can be achieved by spreading leaves, leaving them until they are entirely dry, and then storing them in a clean sack, which is hung from the roof by string to prevent contact with the ground (Jansen van Rensburg *et al*., 2004).

Leaves can be boiled before drying to eliminate micro-organisms. A considerable amount of ascorbic acid (vitamin C) is lost when vegetables are boiled (Jansen van Rensburg *et al*., 2004). Dried vegetables can retain their quality and taste for up to three years by storing appropriately and by avoiding contamination with dirt and moisture. There is no special method of preparing dried leaves compared with preparing fresh leaves for cooking (Jansen van Rensburg *et al*., 2004). However, it is likely that drying can have positive or negative effects on the nutritional quality of leaves. The type of vegetable may be important in determining the effect of drying on food nutrient values (Onayemi & Badifu, 1987). The modern approach of preserving vegetables is freezing, after blanching (keeping vegetables in boiling water or steam for a short period) (Schafer & Munson, 1990). Blanching helps to destroy micro-organisms on the surfaces of vegetables, whereas freezing slows the action of enzymes that cause browning and loss of vitamins (especially vitamin C) (Schafer & Munson, 1990). It was reported that most vegetables can retain good nutritional quality for 12 to 18 months in a frozen condition (Schafer & Munson, 1990).

2.4 Factors with a potential to affect consumption of traditional food

For many decades, factors that affect food consumption trends have been discussed in literature. Among the known factors that affect the consumption of traditional foods are:

1. Lack of interest to use wild edible plants as major sources of food (Association of the Faithful, 2003; Higgins & Chrispeels, 2003; Sinclair & Gardner, 1998; Simonds, 1976)
2. Exponential population growth in developing countries (Sadava, 2003; Welch & Graham, 1999; Buhr & Sinclair, 1998)

3. Urbanisation (Bichard *et al*., 2005; Blisard *et al*., 2002; Fox & Norwood Young, 1982)
4. Globalisation and food trade influencing food access for people in developing countries (FAO, 2004; Story & French, 2004)
5. Income and employment status influencing food access (Blisard *et al*., 2002),
6. Education levels (Blisard *et al*., 2002)
7. Age of consumer (Bichard *et al*., 2005; Khare, 2005; Story & French, 2004)
8. Lifestyle changes influenced by the social and cultural environments (Khare, 2005; Story & French, 2004; Blisard *et al*., 2002)

All the factors listed above influenced dietary preferences by choice or obligation. For example, for those people whose traditional foods are replaced by external forces beyond their control (changing agriculture and market forces), traditional foods may be replaced by exotic foods. Convenience, availability and price of processed foods in urban areas have contributed to the shift of preference towards processed foods (Bichard *et al*., 2005; Story & French, 2004; Kennedy, 2003). Rising incomes, industrial development, population growth and urbanisation have also resulted in a shift away from traditional staple foods to western food consumption habits (World Health Organisation, 2003). Changes in dietary and lifestyle patterns have resulted in chronic and degenerative diseases including obesity, diabetes mellitus, cardiovascular disease, hypertension, strokes, and some types of cancers (Drewnowski & Holden-Wiltse, 1992; World Health Organisation, 2003). In the following sub-section, some of these factors influencing food consumption trends are discussed.

2.4.1 Population growth and food production

A brief historical review of population growth is important for understanding trends in food consumption. Buhr & Sinclair (1998) reported that about 5000 years ago, with the establishment of cities, world population began to increase significantly. Since the beginning of agriculture, there has been an association between increases in human populations and food production. However, Sadava (2003) presented evidence from various sources that food production increases have not been significant in developing countries, where the highest rates of human population growth have occurred, compared with developed countries, where slower population growth and food production have been experienced. It is clear from Sadava's (2003) review that food production increases must keep pace with growing populations in the developing world. However, it is also important to understand that food production increases that are not associated with improvements in nutritional value of crops, may not address micronutrient deficiencies. Plant production is ultimately the basis for the sustenance of most of the human population (Sinclair & Garner, 1998).

The 'Green Revolution' in the 1960s and 1970s led to an increase in food production, for example in south east Asia, that lowered costs (Buhr & Sinclair, 1998). The target populations of the 'Green Revolution' were developing countries in Asia and South America. High-yielding varieties largely replaced traditional and indigenous crops including protein-, micronutrient- and vitamin-rich crops. Consequently, diets in affected countries changed from low-energy-micronutrient-rich to high-energy carbohydrate-based diets (Welch & Graham, 1999). High-energy carbohydrate-based diets have been associated with 'hidden hunger' (micronutrient deficiency) a serious health problem in developing countries (de Rose *et al*. 1993; Welch & Graham, 1999).

As populations increased over the years, and the production of indigenous crops was largely replaced by introduced crops, a shift away from indigenous crops in favour of modern crops occurred (Holley, *et al.*, 2005). Confirming the shift away from traditional crops and warning against the effects thereof, the Board on Science and Technology for International Development (1996) stated that in the last few centuries in Africa, production of local grains has been superseded by exotic cereals that were introduced and promoted by outsiders such as missionaries, colonial powers, and/or researchers. As a consequence, the production of indigenous grains has decreased significantly, as millions of tons of wheat and rice imports have been sold to people in developing countries. The shift away from indigenous crops is likely to be a significant topic for study, to investigate the potential role of indigenous crops in the diets of the present indigenous people of KwaZulu-Natal and South Africa. Such study will reveal that urbanisation is one of the important factors influencing a shift away from consumption of traditional foods.

2.4.2 Effect of urbanisation on consumption of traditional food

Urbanisation and the globalisation of food systems are changing the profile of hunger and malnutrition in developing countries. For the developing world as a whole, per capita consumption of vegetable oils and animal foods, such as meat, dairy, and eggs, doubled between 1961 and 2000 (FAO, 2004) but there is no evidence that all the people in the developing world benefited in terms of better access to nutrition. Where urban growth and rising incomes have increased rapidly, dietary changes have accelerated. Changes in dietary composition (with respect to types and variety of dishes) and increased consumption of processed foods accelerated with changing lifestyles and rapid growth of fast food outlets (Bichard *et al*., 2005). It could be argued that the urban poor cannot afford fast foods. However, they are still influenced by dietary changes occurring as a result of urbanisation (FAO, 2004). Increased levels of obesity, heart disease and other diet-related ailments are rising rapidly in the world, not only in cities but also in rural areas, all influenced by the economic and social changes (FAO, 2004). Detailed reviews on the subject of obesity and dietary lifestyle are available (Gosh *et al*., 2004; Malis *et al*., 2005; Unwin, 2006) however, none of the published literature reviewed in this study explained the relationship between consumption of traditional foods and diseases associated with lifestyle (e.g. diabetes). Hence, it is likely that the benefits of traditional foods have not been widely evaluated or their nutritional values studied with respect to their role in human health.

2.4.3 Effect of education, age and dietary knowledge on food consumption

It has been established that low-income groups, the unemployed, and populations in countries in economic transition often replace traditional micronutrient-rich foods with heavily marketed sugar-sweetened beverages (i.e. soft drinks) and energy-dense fatty, salty and sugary foods (Bichard *et al*., 2005). Unemployed people in South Africa were found to buy the cheapest food available, while the more "educated" bought food because they believed it was healthy (Bichard *et al*., 2005). A study conducted by Blissard *et al*. (2002) on urban consumers in the United States of America, showed that increased education levels were likely to lead to increased consumption of fruits and vegetables. On the other hand, a rise in education levels was found to have a small, negative effect on per capita consumption of beef, pork, other meats, and eggs in the United States of America. This means that the more educated people were in United States, the more likely was their preference for healthier or vegetarian foods (Bichard *et al*., 2005; Shackleton, 2003).

A counter-argument to the former, regarding the role of formal education on food habits, could be that formal education may be associated with loss of traditional knowledge. For example, Bichard *et al*. (2005) found that "educated" (no definition of this term was given in the study) people in Polokwane (Limpopo Province in South Africa) knew less about traditional crops and preparation of traditional foods than illiterate rural people. These educated people regarded traditional foods as being beneath their status (Bichard *et al*., 2005). Fox & Norwood Young (1982) reported that the most knowledgeable people about wild edible plants in the rural areas of South Africa were the elderly. This was confirmed by Modi *et al*. (2006) at Umbumbulu, KwaZulu-Natal, where elderly women were found to be more knowledgeable about traditional plants by recalling more plant names within three minutes than any others who participated in the study. Traditionally, elders share information on identification and cooking of traditional food with children, and older siblings teach younger siblings. However, since the introduction of compulsory formal education, young boys and girls no longer have time to go to the fields with their elders, where they would be taught about wild edible plants (Fox & Norwood Young, 1982). Kwapata & Maliro (1995) found that the younger generation in sub-Saharan Africa lacks knowledge about the existence and nutritional value of wild edible plants. A decline in the use of traditional vegetables by rural dwellers in sub-Saharan Africa has resulted in poor diets and nutrient deficiency disorders and diseases among people (Kwapata & Maliro, 1995).

Consumption of traditional food is also related to gender, and location (Peter *et al*., 2001). Current lifestyles and/or previous exposure to a traditional lifestyle during childhood may influence a person's preference for traditional foods (Peter *et al*., 2001). Generally older people consume more traditional foods than younger people (Peter *et al*., 2001).

A study conducted by Bichard *et al*. (2005) found that eight of 28 interviewees in Polokwane, South Africa, presumed that rural people consumed more sorghum than urban dwellers, because the former had limited access to cereals (e.g. corn flakes, Rice Crispies, etc.). The study found a correlation between choice of sorghum as a cereal and age of consumers. Infants and young children consumed sorghum cereal more than any other cereal (e.g. maize), because they did not make their own food choices. When children grew to be teenagers and young adults (< 30 years), they chose other cereals over sorghum. The colour of sorghum (brown) was found to be a deterrent because it looks like soil (dirt) (Bichard *et al*., 2005). Among middle aged and elderly persons, sorghum was found to be popular, for various reasons, including understanding of health benefits and preferences developed earlier in life (Bichard *et al*., 2005; Shackleton, 2003). The findings of Bichard *et al.*'s (2005) study are important in the context of the perceptions people might have about indigenous and traditional food's physical characteristics compared with modern foods. Indigenous foods that are not refined may be less attractive, and perceptions of people who have had no experience with them as foods may be that they are less nutritious than modern, conventional foods. Consequently, indigenous foods may be excluded from diets. These possible perceptions require further investigation.

2.5 The role of wild leafy vegetables in human nutrition

Although wild leafy vegetables are inexpensive, they are important sources of vitamin A, iron and calcium (Bichard *et al.* 2005). Wild leafy vegetables can provide more than 20%

of the Recommended Dietary Allowance of protein and other nutrients (Bhat & Rhubuluza, 2002; Kwapata & Maliro, 1995). Labadarious (2003) reported that half of the children included in the 1999 South African Food Consumption Survey consumed less than half the recommended dietary allowance to meet micronutrient requirements for their ages. Children in rural areas had poorer nutrient intakes of energy, calcium, iron, zinc, selenium, vitamins A, B6, C, D and E, riboflavin and niacin.

Besides the socio-economic factors, environmental factors also influence traditional food value. For example, minerals and water, which are essential for the growth of plants, play a major role in determining the nutrient contents of traditional foods (Higgins & Chrispeels, 2003). Soils that are rich in organic matter support healthy wild vegetables that are richer in nutrients than vegetables growing on sandy soils. Organic matter retains mineral nutrients and water, which are absorbed by plants, better than sandy soils (Altieri, Merrick & Anderson, 1987). Wild vegetable species also differ in their ability to absorb water and nutrients, depending on root characteristics (depth of soil penetration and spread) and ability to tolerate drought. The deeper and more widespread the root system the more water and nutrients will be absorbed (Altieri, Merrick & Anderson, 1987). Drought tolerance allows plants to absorb water and nutrients even when there is very little soil water available, thus increasing the chances of increasing nutrient content of edible portions (Higgins & Chrispeels, 2003).

2.6 Summary

Traditionally, Zulu foods were prepared from traditional crops including cereals, legumes, cucurbits and wild vegetables. Although Zulus continue using traditional crops, integration with and influence of other cultures has led to modifications by inclusion of modern ingredients, and in some cases replacement of traditional ingredients with modern ones. Lessons from elsewhere in the world showed that human dietary preferences shift, influenced by modernisation and commercialisation of food production practices, human population pressure and preferences for certain types of food. These preferences are influenced by education, age and other factors.

Although the Zulu food culture has been influenced by modernisation, Zulu traditional foods are still served during traditional ceremonies (Anon., 2005; Nyembezi, 1966; Sosibo and Harvey, 2000). However, there is evidence that some contemporary traditional foods are significantly different from the traditional foods used before modernisation. Since the name of a traditional food does not change, even if it is modified by inclusion of exotic ingredients, it is difficult to ascribe nutritional values to a traditional food by relying only on its Zulu name. Therefore, it is important that the nutritional value of the Zulu traditional foods is understood in the context of its ingredients. Information about the nutritional value of traditional foods can be used to promote the use of these foods for the purposes of food security, health improvement and the marketing of Zulu culture.

Whereas there are data to show that traditional foods can be more nutritious than some conventional foods (Modi, 2004) one cannot generalize, without investigation, that traditional foods are more beneficial than conventional foods with respect to their effect on human nutrition and health. In section 2.2 of this chapter, the typical traditional foods consumed in South Africa are shown to consist of cereal grains (mainly maize) and legumes (beans, cowpeas and Bambara groundnuts) as a major portion of a dish that can include wild vegetables, and various cucurbits. The information presented in this chapter, about the typically consumed traditional foods, is in agreement with that published in previous studies (Fox and Norwoord Young, 1982; Mnzava, 1997; Nesamvuni *et al*, 2001).

In section 2.4, it is explained that the socioeconomic situations of people in rural and urban areas influence the changing trends in food preferences. The majority of available studies on factors influencing changing preferences are generally not directly relevant to the present study (for example, fuel supply and people having no time to cook). The relevant studies (e.g. Birchard *et al*., 2005; Nesamvumi *et al.*, 2001; Shackleton, 2003) are limited in scope, based on small surveys in specific locations, and focus either on cereal food preference (Birchard *et al*., 2005) or wild vegetable consumption only (Nesamvumi *et al.*, 2001; Shackleton, 2003) and exclude a wide range of traditional foods and issues related to preferences (e.g. convenience, social status, economic situation, etc.).

The present study focuses on the use of traditional foods in KwaZulu-Natal and seeks to identify the types of recipes submitted for a recipe competition, to determine whether the traditional Zulu foods were prepared from traditional crops, including cereals, legumes, cucurbits and wild vegetables. Lessons from elsewhere in the world showed that dietary preferences shift, influenced by modernisation and commercialisation of food production practices, human population pressure and preferences for certain types of food. Food preferences are influenced by education, age and other factors.

CHAPTER 3

METHODOLOGY

3.1 Background to the study

The KwaZulu-Natal Department of Agriculture and Environmental Affairs (KZN-DAEA) promotes the use of traditional and indigenous foods in the province. To promote these foods, the Department launched a competition for traditional recipes among communities in 2005. The traditional food competition was also an awareness campaign to promote consumption of traditional foods to benefit poor and food-insecure households, since traditional food is made from cheap and locally available raw materials. IsiZulu instructions on the rules pertaining to recipes to be submitted for the competition by members of communities (Appendix A) were distributed by extension officers (Table 3.1: translated) to whom the recipes were submitted. A team of officials from the KZN-DAEA examined the submissions to select finalists and winners of the best recipes, which would be promoted through a booklet on KwaZulu-Natal traditional foods. The winners received financial (R500 to R2500) and material (food vending trolleys) prizes to encourage them to initiate small business enterprises focusing on traditional foods.

Table 3.1 Traditional foods competition criteria for communities in KwaZulu-Natal

Criterion number	**Criteria described**
1	The competition was open to residents of KwaZulu-Natal, except employees of the Department of Agriculture and Environmental Affairs and their immediate families.
2	A recipe should be accompanied by the personal details of the contestant.
3	The Department was granted the right to publish any recipe submitted by the contestants.
4	The Department reserved the right to manipulate successful recipes in order to improve their quality.
5	The ten best recipes would be announced at functions held at the local municipalities.
6	The winners at the local municipality in each district would proceed as finalists to the regional level, where the winners would be announced.
7	The judges' decisions would be final.

Participants in the competition were given instructions to enter categories of recipes as shown in Table 3.2.

Table 3.2 Participants and recipe types for the traditional foods competition initiated by KZN-DAEA in 2005

Participant group	Food category 1	Food category 2
Youth	Traditional snacks	Traditional beverages
Adults	Energy foods, vegetables	Meat or fish, vegetables, fruits and grains

3.2 Analysis of secondary data

The KZN-DAEA entered into an agreement with the African Centre for Food Security of the University of KwaZulu-Natal to:

- Analyse the recipes for preferences in terms of common recipes and ingredients
- Classify the dishes as traditional, modern or modified
- Provide an assessment of the nutritional value of the dishes

The recipes submitted by participants in the competition were translated into English. The researcher determined the nutritional value and preference of recipes listed by participants in the competition. The Medical Research Council's Nutrient Composition Tables and Quantities Manuals were used to determine the nutritional value of the recipes (Kruger *et al*. 1998; Langenhoven *et al.* 1991). Internet sources were also used where information could not be found in the Medical Research Council's nutrient composition tables (National Public Health Institute, 2005). Microsoft Excel was used to enter data, including the locations where the competition took place, and the names of individual participants. Recipes from each participant in the competition were entered using the names given by the participants. All the ingredients of a recipe were listed and the nutrient contents determined from the sum of nutrient values for individual ingredients.

3.2.1 General approach used for determination of nutrient values

Nutrient analysis was based on cooked foods (Wenhold & Faber, 2006) and the nutrient contents of all the ingredient components of a dish were calculated separately. For example, the nutrient contribution from maize meal (flour) and wild leafy vegetables was determined separately according to the quantities of ingredients and then added to calculate the nutrient value of *isijabane* (maize meal mixed with leafy vegetables). The nutrient values of white maize were used where maize was mentioned in a recipe as participants did not mention the type of maize used. The nutrient values of margarine (hard brick) were used where margarine was mentioned in a recipe since that is the one that is commonly used in rural areas. Holsum® could not be found in the MRC food composition tables or on the Internet, therefore, the nutrient values of white cooking fat were used where Holsum® was mentioned in a recipe. Where beans were mentioned in a recipe, the nutrient values of dried sugar beans were used. The nutrient values of sunflower oil were used where cooking oil was mentioned in a recipe. The nutrient values for *marog* (wild vegetables) were used where a recipe called for wild vegetables without specifying. Nutrient values of *amaranthus* were not found the MRC food composition tables , therefore the nutrient values of spinach were used.

Medium-size portion sizes were used to look up nutrient values where quantities were not specified in a recipe. Where conversion quantities could not be found, the quantities of the closest ingredient were used, for example, quantities for spinach were used whenever *amaranthus* or any wild vegetables quantities were needed. The nutrient values of some ingredients could not be found. Some food items, such as fermented products, could not be evaluated for nutrients because they were not available in the MRC food composition tables..

Some recipes indicated cups or mugs as measures of ingredients. In order to measure nutrient values of recipes, cups, mugs and litres were converted into grams. For example, in the Quantities Manual (Langenhoven *et al.* 1991), it was estimated that 125 ml of sugar is equal to 100 grams and equal to half a cup of sugar. Therefore, five cups of sugar converted to 1000 grams. To convert one spoon of salt into grams, a level tablespoon, which is 12 ml, was used. For liquids, it was found that 250 ml is equal to 250 grams. It was assumed that one typical jug used in rural areas (personal experience) was equal to 1.5 litres. If an ingredient did not have any measurements, one unit (e.g. one gram) was assumed, to avoid missing values during statistical analysis.

To estimate the total nutrients for each recipe, the sum of nutrients for each ingredient was multiplied by the weight of ingredients in grams, i.e. Total Nutrient = weight of ingredient one in grams x nutrient value ÷ 100g + weight of ingredient two in grams x nutrient value ÷ 100g. Where the serving size was not stated, it was assumed that the family size was six. To arrive at the total nutrients per portion, total nutrients were divided by the servings or household size (the number of people that the recipe was prepared for) if servings were not known. For example, if total energy for biltong was 17.19 kJ and the biltong was prepared for six people, then 17.19 kJ was divided by six to get 2.865 kJ per serving. As explained in section 3.1, the study design was largely influenced by the fact that The KZN-DAEA entered into an agreement with the African Centre for Food Security of the University of KwaZulu-Natal to analyse data obtained from a traditional recipe competition. Therefore the foods (recipes) could not be cooked and analysed for nutrient content in the laboratory by the author of this dissertation. Secondary data (MRC Food Composition tables) were thus used to estimate the nutrient contents of the resipes. However, this methodological approach has limitations, which are acknowledged in section 1.4.

3.2.2 Classification of food as traditional, modern or modified

Participants in the KZN-DAEA competition were asked to submit traditional recipes and these recipes were classified by the researcher as traditional, modern or modified. Traditional ingredients were defined as wild edible plants (only wild leafy vegetables were found in the dishes) indigenous crops (e.g. cowpeas and sorghum) and traditional crops (e.g. maize, beans, groundnuts, Bambara groundnuts and pumpkins). These dishes were generally cooked by boiling and salt was added.

Modern dishes comprised conventional crops (e.g. wheat, cultivated fruits and tomatoes) and fats/oils and spices. Modified dishes contained ingredients from both traditional and modern dishes, regardless of the proportions used. Unprocessed or sun-dried meat was regarded as traditional food, but use of purchased spices (excluding salt) would make biltong a modern food.

3.2.3 Determination of Estimated Average Requirement (EAR) of nutrients

As reviewed earlier (Chapter 2) there are major deficiencies of the minerals calcium, iron and zinc, and the vitamins A, B12, C and E in the rural areas of South Africa, including rural KwaZulu-Natal. For this reason, the contribution of the 10 most popular recipes to the Estimated Average Requirement (EAR) of these nutrients (except calcium, for which there is no EAR value) was estimated using published EAR data (Nutrition Information Centre (NICUS), 2003). EAR is an estimate of the average nutrient requirements for groups of people (NICUS, 2003). The EAR was used rather than Recommended Daily Allowances as the portion sizes were estimated from the total recipe volume and did not take into account variability in individual portion sizes that, in reality, would vary by gender, age and other factors. EAR values for females between 18 – 30 and 19 – 50 were very similar for the two age groups (NICUS, 2003) and were used to determine nutrient adequacy for comparing the relative contribution of the food to average diets.

3.2.4 Data analysis

To compare districts, in terms of recipes (traditional, modern and modified) to gender and age of participants, data were tabulated and totals for each category inspected. These data made it possible to calculate proportions of each category (recipe type, gender and age). Data for nutrients were summarised using Microsoft Excel (version 2003). Totals of individual nutrients were used to determine the nutritional value of recipes. The Data Analysis Toolpak of Microsoft Excel was used to rank the recipes. For ease of comparison and discussion, the top ten recipes, determined by popularity (high scores) were selected for further comparison of recipe types in terms of nutrient composition. Pearson's correlation analysis was used to determine relationships between popularity and nutrient values. Regression analysis was used to explain the relationship between popularity and nutrient values. Analysis of variance (GenStat version 9) was used to determine differences between recipes in terms of nutrient values at $P = 0.05$. Data are presented as means and standard errors.

CHAPTER 4

RESULTS AND DISCUSSION

The overall aim of the study was to investigate the nutritional value of the recipes that were submitted for a competition in terms of traditional, modified and modern foods. The terms ‘modified’ and ‘modern’ were derived from a theoretical framework to determine changes that may have been made to each recipe, so that it no longer qualified as a traditional food. The results are discussed to compare recipes in the first instance, and how nutritious the resultant foods are in the second instance. This approach helps determine whether the participants used ingredients that modified traditional foods and what the implications of such a modification on the nutritional value of traditional foods are.

4.1 What recipe types were submitted as classified as traditional, modern and modified?

There are 11 districts in KwaZulu-Natal (Appendix C). These districts are located in areas that are different in terms of population density and infrastructure. In this section, findings about the distribution of submitted recipes are presented in two subsections: section 4.1.1 explains how the participants in this study were distributed across the districts and how the population density in each district is correlated with the occurrence of traditional, modern and modified recipes. Section 4.1.2 explains the distribution of recipes by gender and age at each district, and districts are compared in terms of popularity of recipes.

4.1.1 Distribution of recipe types in districts in relation to population

The highest number of recipes submitted were traditional recipes (68%) followed by modified (24%) and modern (8%) recipes (Table 4.1). More than a quarter (29%) of all recipes (1200) submitted came from the Zululand District Municipality. Recipes from Umzinyathi, which had the second highest number of submitted recipes, contributed 19%

to the total submissions. These two districts, Zululand and Umzinyathi, consistently ranked first and second in all districts in terms of the number of traditional, modern and modified recipes submitted (Table 4.1.).

Table 4.1 Comparison of KwaZulu-Natal districts for the distribution of traditional, modern and modified recipes

District	Traditional		Modern		Modified	
	Number of recipes	**Rank order**	**Number of recipes**	**Rank order**	**Number of recipes**	**Rank order**
Zululand	226 a	1	34 a	1	86 a	1
Umzinyathi	167 b	2	21 b	2	44 b	2
Uthungulu	122 c	3	6 d	5	20 c	4
Amajuba	82 d	4	12 c	3	38 b	3
Uthukela	42 e	5	7 d	4	17 c	5
Umkhanyakude	40 e	6	4 de	7	20 c	4
Ilembe	35 ef	7	4 de	7	10 cd	7
Umgungundlovu	33 ef	8	3 de	8	20 c	4
Sisonke	28 ef	9	5 d	6	13 c	6
Ethekwini	19 ef	10	4 de	7	7 cde	8
Ugu	19 ef	10	5 d	6	7 cde	8
Total	**813**		**105**		**282**	
Mean	**73.9**		**9.5**		**25.6**	
Standard Error	20.8		2.9		7	

Note: Numbers sharing the same letter are not significantly different (according to the Least Significant Difference test).

The remaining districts displayed rankings for the quantities of recipes across food types as follows: Uthungulu (12.3% of 1200 recipe entries) Amajuba (11%), uThukela (5.5%) Umkhanyakude (5.3%) Umgungundlovu (4.7%) Ilembe (4.1%) Sisonke (3.8%) Ugu (2.6%) and eThekwini (2.5%). The differences among districts with respect to the popularity of traditional, modern and modified food types, respectively, are shown by the rankings displayed in Table 4.1. A comparison within recipe types showed that there was a significant difference among districts in terms of distribution of submitted recipes (Table 4.1). The majority of recipes were traditional, followed by modified and modern recipes, respectively.

Regions were compared by district population density (Appendix C) to determine the relationship between population and occurrence of recipe types (Table 4.2). From Table 4.2, it is clear that there was no significant correlation between district population size and recipe type. However, there was a significant correlation between recipe types, i.e. traditional food vs. modern recipe type; traditional vs. modified food type and modern food type vs. modified food type (Table 4.2). The significant relationship between recipe types indicates coexistence of traditional, modern and modified foods in KwaZulu-Natal across all regions, which means that all these recipes were found and used simultaneously.

Table 4.2 Pearson correlation coefficients of relationships between regional population and occurrence of traditional, modern and modified recipes in KwaZulu-Natal

Recipe type	*Population*	*Traditional recipe*	*Modern recipe*
Traditional	0.20 NS		
Modern	-0.06 NS	0.92*	
Modified	-0.02NS	0.91*	0.96*

*Note: NS = not significant; * = significant at p = 0.05*

In general, higher population densities are found in urban areas than in rural areas, where there are fewer people per land area (Anon., 2007). For the purposes of this study, it would be misleading to say that urban districts were characterised by traditional food, because most recipes (traditional or not) came from the most rural districts (Tables 4.1 and 4.3).

The latest information from Statistics South Africa (Stats SA, 2008) does not specify the ratio of rural to urban population density in South Africa, but other sources estimate that there are slightly more than 50% of the people living in urban areas in South Africa (Anon, 2007). No similar data about KwaZulu-Natal were found. It is, however, known that there are 10.11 million people in KwaZulu-Natal, of which, 79% are African and 52% are female (Stats SA, 2008). As it is the case in the rest of South Africa, the highest population densities in KwaZulu-Natal are found in the cities of Durban and Pietermaritzburg, respectively (Anon, 2007). These cities are found in the eThekwini and Umgungundlovu districts (Appendix C). The most rural and the poorest of all district municipalities is Umkhanyakude (Mpilonhle, 2007).

It would be expected that, in urban areas, modern foods would be more prevalently consumed than traditional foods. Districts with large urban centres, such as eThekwini and uMgungundlovu, had fewer submissions compared to Zululand district, suggesting the possible loss of traditional knowledge on food in districts with large urban populations. It is possible that the tendency to have traditional foods associated with higher population densities in KwaZulu-Natal is caused by the migrants from rural areas still being aware of traditional food types, not necessarily that they actually consume them regularly. It is important to remember that the data used in this study was based on a submission for a traditional food competition (Appendix B). Therefore, participants, whether in rural or urban areas, were likely to have been biased in their selection of recipes in favour of traditional foods. It is, however, interesting to note, that although participants might have adopted new recipes, they still know the traditional recipes. They are likely to still use them, e.g. for traditional occasions. What is significant about the data shown in Tables 4.1 and 4.2 as well as Figure 4.2 and 4.3, is that traditional foods are modified. It can also be suggested that the use of modern ingredients (e.g. spices) have created foods that can no longer be qualified as traditional..

4.1.2 Distribution of recipe types by gender and age of participants

In all districts, females submitted more recipes (91%) than males, who submitted only 5% of the recipes (Table 4.3). Three percent (3%) of the recipes did not indicate whether they had been submitted by males or females. Across all regions, adult females submitted the largest number of recipes followed, respectively, by young females, adult males and young males (Table 4.3).

The largest number of recipes came from Zululand, and the smallest number came from the eThekwini district (Table 4.3). A further analysis of the data in Table 4.3, in conjunction with Table 4.1, indicated that the ranking of districts was important in determining recipe contributions made by people of different ages and genders (Table 4.4). From Table 4.4, it is clear that there was concurrence in the ranking of districts, although there were a few position (rank) changes from one recipe type to another. The relationship between the rankings of traditional recipes and contribution of recipes by different gender and age groups was negative (Table 4.4). The relationships shown as negative in Table 4.4, indicate that rank one (which indicates prevalence of recipes), was associated with the highest number of recipes. Therefore, the relationships indicated by a minus sign (-) are in fact positive, because rank one is the highest rank, and rank 10 is the lowest rank for prevalence of recipes. This relationship is further explained in Figure 4.4, where Zululand, ranked one, the highest rank, was associated with the highest number of adult female recipes submitted (257); eThekwini and Ugu, both ranked 10, the lowest rank, were associated with the lowest number of recipes submitted, 18 and 28, respectively.

Table 4.3 Comparison of districts for the number of recipes made by adult females, adult males, youth female, youth male and unknown persons

	Number of submissions					
Districts	**Adult female**	**Adult male**	**Youth female**	**Youth male**	**Unknown gender**	**Total**
Amajuba	78	4	46	4	0	**132**
eThekwini	18	3	4	0	5	**30**
Ilembe	36	2	6	1	4	**49**
Sisonke	38	0	6	0	2	**46**
Ugu	28	0	2	1	0	**31**
Umgungundlovu	34	1	15	0	6	**56**
Umkhanyakude	47	4	10	3	0	**64**
Umzinyathi	154	21	41	7	9	**232**
Uthukela	46	0	18	2	0	**66**
Uthungulu	103	1	38	3	3	**148**
Zululand	257	3	72	2	12	**346**
Total	**839**	**39**	**258**	**23**	**41**	**1200**

Across all food types, district rankings were not significantly correlated with adult male recipe submissions (Table 4.4; Figure 4.1). Recipes submitted by adult males were also not significantly correlated with adult female, nor female youths' [Unfortunately 'youth' cannot function as an adjective in the way that 'adult' can, unless you use 'youthful' which alters the meaning] recipes (Table 4.4). However, there was a highly significant ($p < 0.001$) correlation between the number of recipes submitted by adult males and male youths. Recipes submitted by male youths were significantly correlated with adult male, but not with adult and female youths’ recipes (Table 4.4).

Table 4.4 Pearson correlation coefficients of the relationship between district rank and recipes submitted by adults, youth and unknown recipes

	District (Traditional rank)	District (Modern rank)	District (Modified rank)	Adult female	Adult male	Youth female	Youth male
District (Modern rank)	0.82***		-	-	-	-	-
District (Modified rank)	0.88***	0.71**	-	-	-	-	-
AF	-0.84***	-0.84***	-0.80***	-	-	-	-
AM	-0.47NS	-0.47NS	-0.46NS	0.41NS	-	-	-
YF	-0.89***	-0.86***	-0.87***	0.92***	0.34NS	-	-
YM	-0.74**	-0.65**	-0.64*	0.49NS	0.82***	0.54NS	-
UN	-0.46NS	-0.43NS	-0.51*	0.74***	0.46NS	0.58NS	0.16NS

*Note: NS = not significant; * = significant at $p \leq 0.05$; ** = significant at $p \leq 0.01$; *** = significant at $p \leq 0.001$*

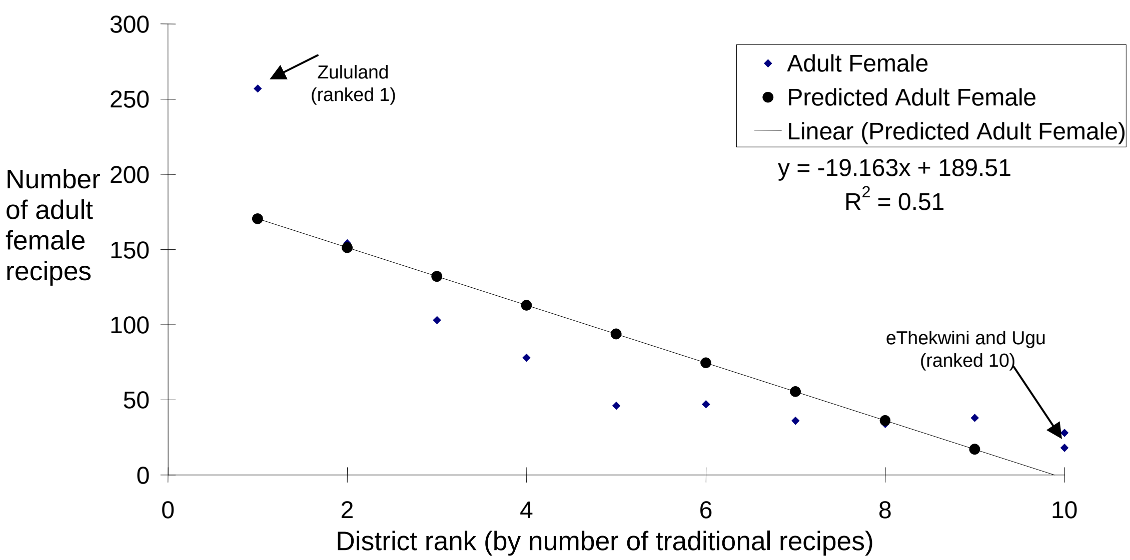

Figure 4.1: Linear relationship between ranking of districts and number of recipes submitted by adult females

Clearly, it is women who influence the foods consumed in KwaZulu-Natal regions. In Zulu culture, men generally do not cook (Mpilonhle, 2007). Therefore, any interventions to explore and improve food systems in the KwaZulu-Natal should be targeted at adult females, followed by young females, and lastly men (both young and adult) (Berti *et al*., 2004; Bourne *et al*., 2002; Modi *et al*., 2006; Lykke *et al*., 2002).

4.2 What were the most popular recipes submitted?

There were 1200 recipes submitted (Appendix A). All recipes were subjected to the determination of nutrient content (see section 4.3). The 1200 recipes were grouped by names to make 281 dishes, before being ranked in order of popularity, which was determined by the number of entries per recipe = popularity index (Appendix D). From the list shown in Appendix D, the most popular recipes were selected on the basis of statistical determination of the differences in terms of popularity (Table 4.5). Using Table 4.5, it was decided that recipes that had at least 2% popularity index would be subjected to further statistical analysis to determine differences in nutritional values.

Of the 281 recipes, 10 met the minimum requirement of the 2% popularity index. These recipes, and their popularity indices, are shown in Figure 4.2. The mean popularity index was about 4.29 (0.36 %), and the maximum was 89 (7.42 %). The standard deviation of popularity values (11.135 ≅ 0.928 %) indicates that the top 10 recipes could be clustered into three groups. *Isijabane* (wild vegetables and maize meal); pumpkin leaves, biltong, mealie bread, *isiphuphutho* (maize grains and beans); wild leafy vegetables; *umbhaqanga* (beans and maize meal), African traditional beer; *isijingi* (pumkin and maize meal) and *amahewu* (fermented maize meal porridge). When analysing the 10 recipes that met the 2% popularity index, the “mean popularity index (4.29)” would be the most important statistic as it indicates that there was an average 4.29 (approx. 4) submissions of each of the 10 popular recipes during the competition.

Table 4.5 Descriptive statistics analysis of all recipes (n = 1200) submitted

Statistic	Value
Mean	4.270462633
Standard Error	0.66428464
Median	1
Mode	1
Standard Deviation	11.1354397
Sample Variance	123.9980173
Kurtosis	30.31449925
Skewness	5.32498094
Range	89 -1 = 88
Minimum	1
Maximum	89
Sum	1200
Count	281
Largest(1)	89
Smallest(1)	1
Confidence level (95%)	1.307

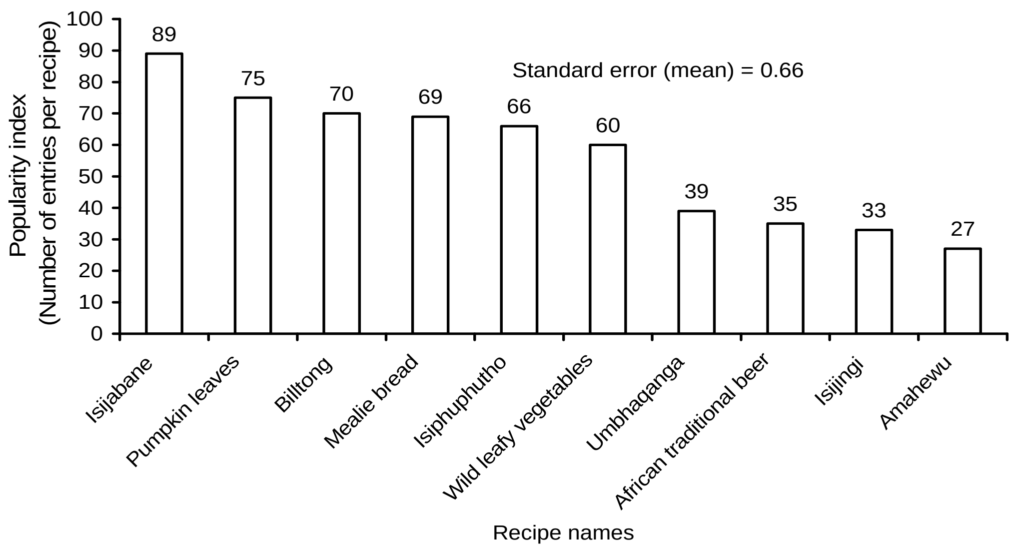

Figure 4.2: The ten most popular recipes determined by number of entries per recipe as a popularity index

Regardless of the grouping, there were significant differences (standard error = 0.66) among all the recipes, in terms of popularity index (Figure 4.2). Distribution of the top 10 recipes across regions, ages and gender is shown in Tables 4.6 and 4.7. From Table 4.6, it is clear that the pattern of recipe popularity within a district was generally similar to that found in the whole province (Figure 4.2). Therefore, further analysis of the data in Table 4.6 was conducted to explore the differences among districts in terms of occurrence of popular recipes. The differences were viewed from two perspectives: (i) across all regions of the province, i.e. taking into account all 1200 recipe entries (Figure 4.3) and (ii) within the top 10 recipes, i.e. taking into account the 563 recipe entries making up the 10 most popular recipes (Figure 4.4). It is important at this stage to note that the top 10 recipes constituted 47% (563) of the total (1200) recipe entries submitted.

Table 4.6 Occurrence of top 10 popular recipes by regions of KwaZulu-Natal

Recipe name	**Amajuba**	**eThekwini**	**Ilembe**	**Sisonke**	**Ugu**	**Umgungund**	**Umkhanyak**	**Umzinyathi**	**Uthukela**	**Uthungulu**	**Zululand**	**Total**
Isijabane	11	2	2	7	3	3	6	24	6	8	17	89
Pumpkin leaves	2	2	3	2	3	3	4	13	7	10	26	75
Biltong	6	1	0	4	2	0	2	19	4	8	24	70
Izinkobe zikabhonshisi /Isiphuphutho	2	0	4	2	4	4	1	17	3	6	23	66
Mealie bread	7	3	6	4	1	1	7	16	3	11	10	69
Wild leafy vegetables	4	2	4	2	2	0	3	14	3	6	20	60
Umbhaqanga	8	0	1	0	0	2	0	14	2	4	8	39
Traditional beer	7	2	3	1	0	2	1	8	2	4	5	35
Isijingi	8	0	2	0	1	3	0	3	4	3	9	33
Amahewu	2	1	0	2	0	1	1	6	2	1	11	27

From Table 4.6, it can be stated that 12.8% of all the most popular recipes came from the Zululand district. The district of eThekwini recorded the lowest number of popular recipes. From Figures 4.3 and 4.4 it is evident that the most popular recipes came from the most rural districts.

Section 4.1 saw the determination of the origins of traditional foods of KwaZulu-Natal and their perceived modifications. The relationships among origin, the people who submitted the recipes and the popularity of the recipes were also explained. The identification of the popularity of a recipe requires explanation as to why the recipe is popular. Hence, from section 4.5, the top 10 recipes will be described in terms of nutritional value, so that an explanation can be given as to whether there is a relationship between popularity and nutritional value.

Table 4.7 Ten most popular recipes by submission demographics

	Number of submissions														
	Traditional recipe					**Modern recipe**				**Modified recipe**					**Total**
Recipes	**Adult female**	**Adult male**	**Youth female**	**Youth male**	**Unknown**	**Adult female**	**Adult male**	**Youth female**	**Youth male**	**Adult female**	**Adult male**	**Youth female**	**Youth male**	**Unknown**	
Isijabane	54	1	3	0	2	0	0	0	0	26	0	3	0	0	89
Pumpkin leaves	37	0	4	0	0	0	0	0	0	26	2	3	1	2	75
Biltong	55	6	4	0	2	0	0	0	0	3	0	0	0	0	70
Izinkobe zikabhonshisi/Isiphuphutho	44	3	7	0	1	0	0	0	0	10	0	1	0	0	66
Mealie bread	21	2	4	0	0	1	0	0	0	29	1	9	2	0	69
Wild leafy vegetables	34	2	1	0	0	0	0	0	0	22	1	0	0	0	60
Umbhaqanga	31	0	2	1	2	0	0	0	0	3	0	0	0	0	39
Traditional beer	7	2	19	3	2	0	0	0	0	0	0	2	0	0	35
Isijingi	26	1	4	0	0	0	0	0	0	2	0	0	0	0	33
Amahewu	3	0	14	4	0	0	0	0	0	0	0	5	1	0	27

4.3 How did modification affect nutritional quality of recipes?

An analysis of the recipes for nutrient values was undertaken from two perspectives (Appendix F): comparison of the top 10 recipes and comparison of recipe types (traditional, modern and modified).

4.3.1 Energy content of recipes

There was a significant difference among recipe types, with respect to total energy (Table 4.8). Regardless of whether the food was modern, modified or traditional, traditional beer showed the highest energy content per 100g, followed by mealie bread and *umbhaqanga; Isiphuphutho* had the third highest energy content. *Amahewu* and *isijingi* had the fourth highest energy content (Figure 4.5). Biltong had the lowest energy content, but its energy content was not significantly different from *isijabane*, pumpkin leaves and wild leafy vegetables (Figure 4.5).

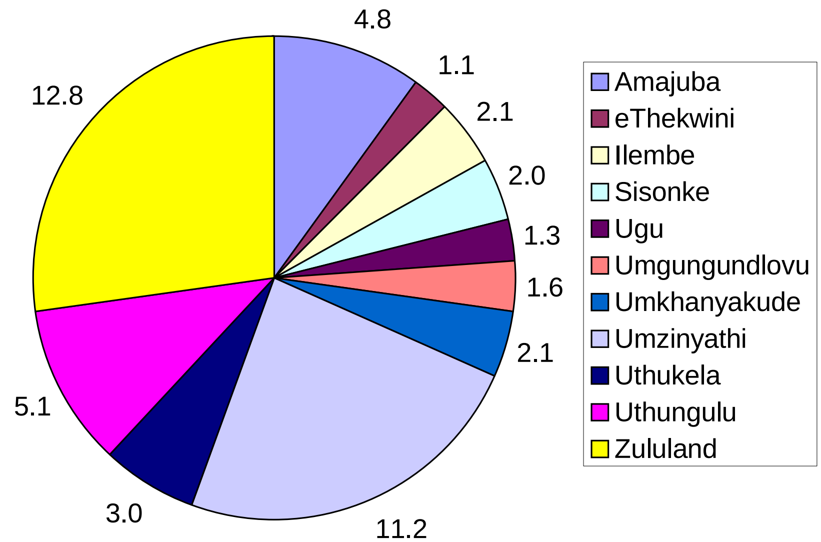

Figure 4.3: Distribution of the 10 most popular recipes submitted from all KwaZulu-Natal regions

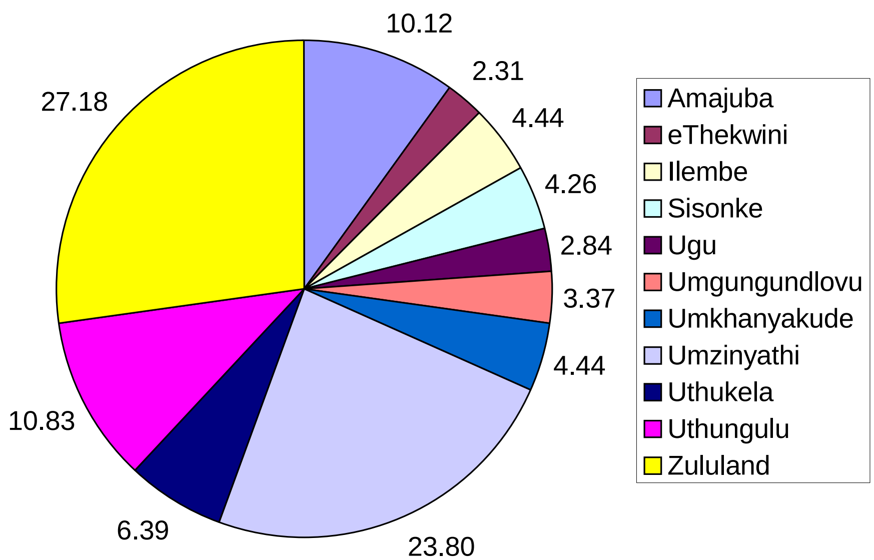

Figure 4.4: Distribution of the 10 most popular recipes submitted.

Table 4.8 Energy contents of the top 10 popular recipes when they were prepared as traditional or modern or modified types (kJ/serving portion).

	Energy content of recipes in kJ/serving portion		
Recipe name	**Traditional recipe**	**Modern recipe**	**Modified recipe**
Amahewu	592.80	-	1104.46
Biltong	170.75	-	377.58
Isijabane	397.71	-	391.83
Isijingi	398.12	-	1263.47
Isiphuphutho	1333.26	-	1053.92
Mealie bread	364.68	2168.53	1271.82
Pumpkin leaves	496.21	-	240.27
Traditional beer	3370.06	-	3862.08
Umbhaqanga	879.22	-	2510.84
Wild leafy vegetables	198.43	-	371.38
Mean	820.12	216.85	1244.76
Standard error	30.99	26.19	33.81
Total mean	**760.58**		

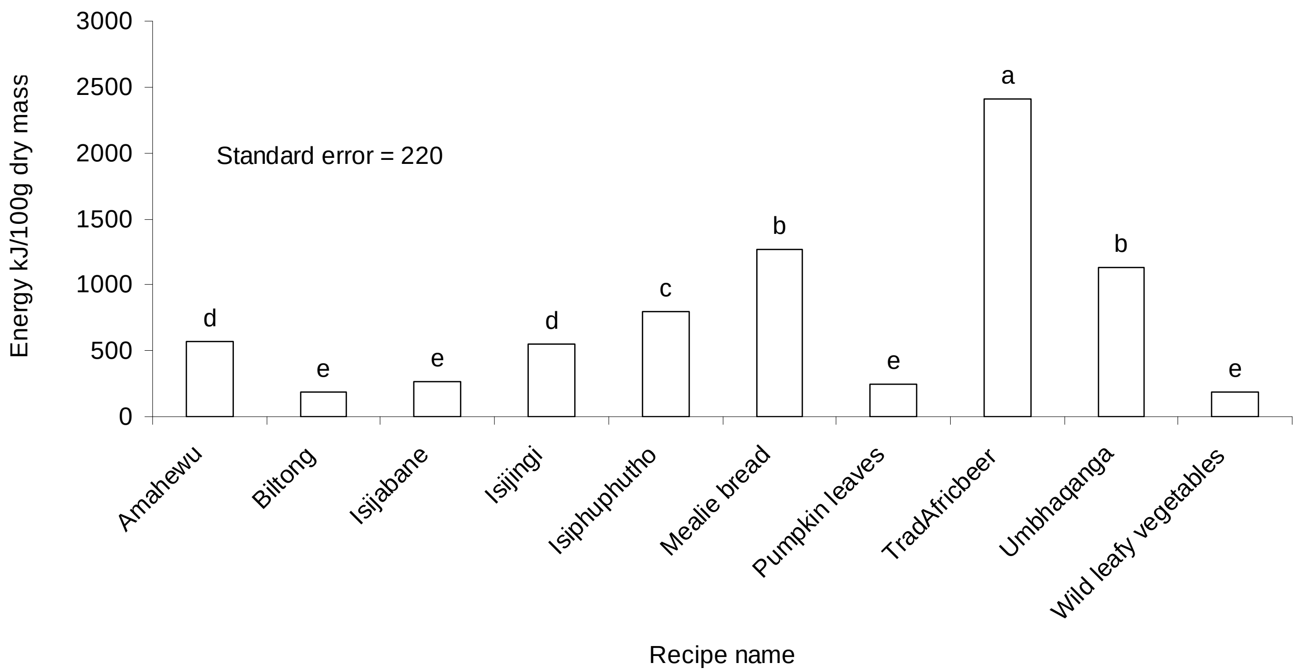

Figure 4.5: Total energy content of the top ten recipes from KwaZulu-Natal.

Bars sharing the same letter are not significantly different from each other.

Note: TradAfricbeer = traditional African beer.

In general, modified food recipes contained higher energy contents than traditional and modern recipe types (Table 4.8). The results shown in Figure 4.5 and Table 4.8 were not surprising in that traditional beer was expected to have a higher energy content because of fermentation (Achinewhu, 1983; Oladele and OShodi, 2008). The energy of a*mahewu* was reduced due to fermentation as was shown by Bvochora *et al*. (1999). Mealie bread, being made from starch-rich maize, was expected to have a relatively high energy content. The high energy content of *umbhaqanga* may have been due to a higher proportion of maize than beans, compared with *isiphuphutho* (Figure 4.5). Preparations of i*sijabane* and *isijingi* involve, respectively, mixing wild vegetables and pumpkin flesh. However, mixing maize and pumpkin may have less of an effect on food energy than in the case of *isijabane* (Figure 4.5). Biltong, pumpkin leaves and wild leafy vegetables do not have a starch or carbohydrate-rich constituent, hence their low energy content. Biltong was expected to have more energy than leafy vegetables, because of the high protein and fat contents (Langenhoven *et al*., 1991). It is difficult to explain this discrepancy.

From Table 4.8, it is evident that modification of traditional food was associated with an increase in energy contents except for *isiphuphutho* and pumpkin leaves, which decreased. Extreme increases in energy content from traditional to modified food were observed in *isijingi and umbhaqanga* (approximately 300%). The energy of wild leafy vegetables was almost doubled by modification (Table 4.8). *Isijabane* was virtually unchanged, in terms of energy content (Table 4.9) by modification involving the addition of sugar and salt (Henry & Massey, 2001).

To determine the relationship between recipe popularity and energy content, popularity indices (number of entries per recipe across all KwaZulu-Natal districts) were correlated with energy content of traditional, modern and modified recipes. Results showed that there was a negative correlation between popularity and energy content of traditional and modified foods, and a positive correlation between popularity and modern foods. However, it was only the relationship between popularity and energy of modified foods that was statistically significant (Figure 4.6), although the R^2 value was rather low (0.40).

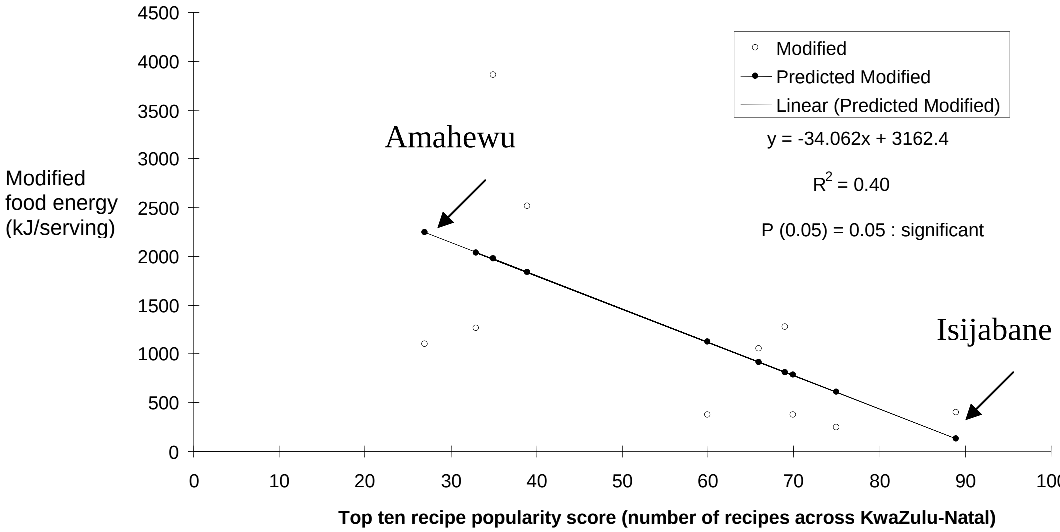

Figure 4.6: Relationship between modified food popularity and energy content.

From Figure 4.6, it is clear that the most popular recipe, *isijabane* had the lowest energy content compared to the least popular recipe, *amahewu*, which had the highest energy content. However, it is common knowledge that *amahewu* is made of maize (a high starch grain) and in *isijabane* there are more wild leafy vegetables than maize, which is likely to be the reason for the reduced energy content. *Isijabane* probably tastes more delicious than *amahewu* (a sour porridge that is mainly used during the warm season as both a thirst quencher and a quick food between main meals) (Mokoena *et al*., 2006).

In African culture, across all ethnic groups, *amahewu* is more popular with males, although prepared by women. *Isijabane*, on the other hand, is popular with women, and men generally do not like to eat it (Modi, 2004). Popularity of a recipe could be associated with the availability of raw materials and preparation time (Jolly, 2006). *Amahewu* is made from readily available ingredients (maize meal and water) but takes many hours (normally overnight) to prepare (Jolly, 2006). *Isijabane* requires wild leafy vegetables, which can be picked from cultivated fields or the veld (Modi, 2004). Maize grain must be ground into mealie rice before use as an ingredient of *isijabane.* From the start of cooking to serving, *isijabane* can be ready in about 20 to 30 minutes (Jolly, 2006). Therefore, *isijabane* is quicker to make than *amahewu*, but *amahewu* ingredients are easier to access. Whether the differences in cooking time and access to ingredients in the recipes can be used to determine popularity is difficult to conclude, because it has not been tested in this study. However, it can be inferred from Tables 4.3 and 4.4 that popularity trends (Figure 4.6) of recipes may be related to female preference.

4.3.2 Macronutrients and dietary fibre

Data shown in Figure 4.7 indicate that there were significant differences among recipes in terms of macronutrient content. Traditional African beer showed the highest carbohydrate content compared with other recipes (Figure 4.7). Mealie bread showed the second highest carbohydrate content, followed by both *amahewu* and isijingi, then *isiphuphutho* and *umbhaqanga*, followed by *isijabane*, and the least carbohydrate content (trace levels) was in wild leafy vegetables and biltong (Figure 4.7). In all recipes, except those using wild leafy vegetables and biltong, carbohydrates were the predominant macronutrient (Figure 4.7).

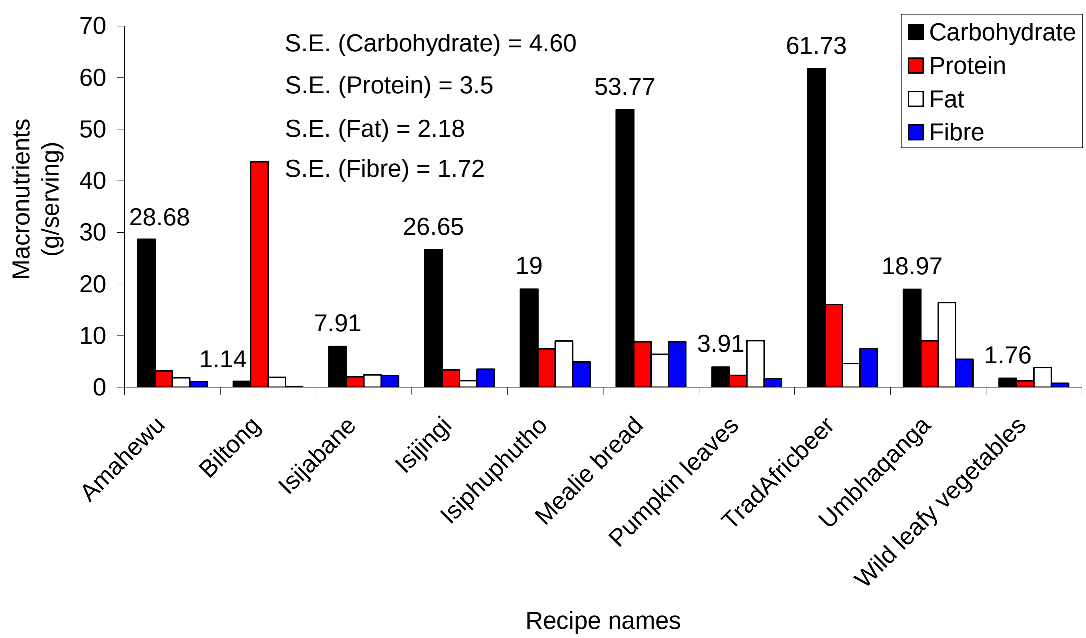

Figure 4.7: Macronutrients and fibre content of the 10 most popular recipes submitted.

Protein content was also significantly highest in traditional African beer compared with non-meat recipes (Figure 4.7). This observation was unexpected, because traditional

African beer is made of maize, which has a lower protein content than beans. Maize is about 10% protein, whereas beans are about 23% protein (Bewley and Black, 1994). Hence, *isiphuphutho* and *umbhaqanga* (both made of maize and beans) were expected to show the highest protein levels among vegetable foods, and, as expected, biltong had more protein content than all plant foods. Mealie bread, *isiphuphutho* and *umbhaqanga* had statistically the same amount of protein (Figure 4.7). There was a significant difference among other recipes in terms of protein content (Figure 4.7).

The highest fat content was found in umbhaqanga, followed by *isiphuphutho* (a recipe with similar ingredients to *umbhaqanga*) and pumpkin leaves (Figure 4.7). The other recipes, shown in Figure 4.7, had the lowest fat content and were not significantly different from each other (Figure 4.7). The highest fibre content was found in mealie bread, followed by traditional African beer, *isiphuphutho* and *umbhaqanga*, which were not statistically significantly different in terms of macronutrients, followed by *isijingi* (Figure 4.7). The remaining recipes had traces of fibre (Figure 4.7). The significantly higher fibre content in traditional African beer, compared to *isijingi*, pumpkin leaves and wild leafy vegetables, was surprising because traditional African beer is a beverage. It was expected to have a fibre content similar to that of *amahewu* (Figure 4.7) yet it did not.

A comparison of traditional, modern and modified foods showed that modified foods contained the highest macronutrient content and fibre, followed, respectively, by traditional and modern foods (Figure 4.8). The high mean protein values shown in Figure 4.8 were strongly influenced by the high amount of protein in biltong, which was about ten times more than any plant-based food.

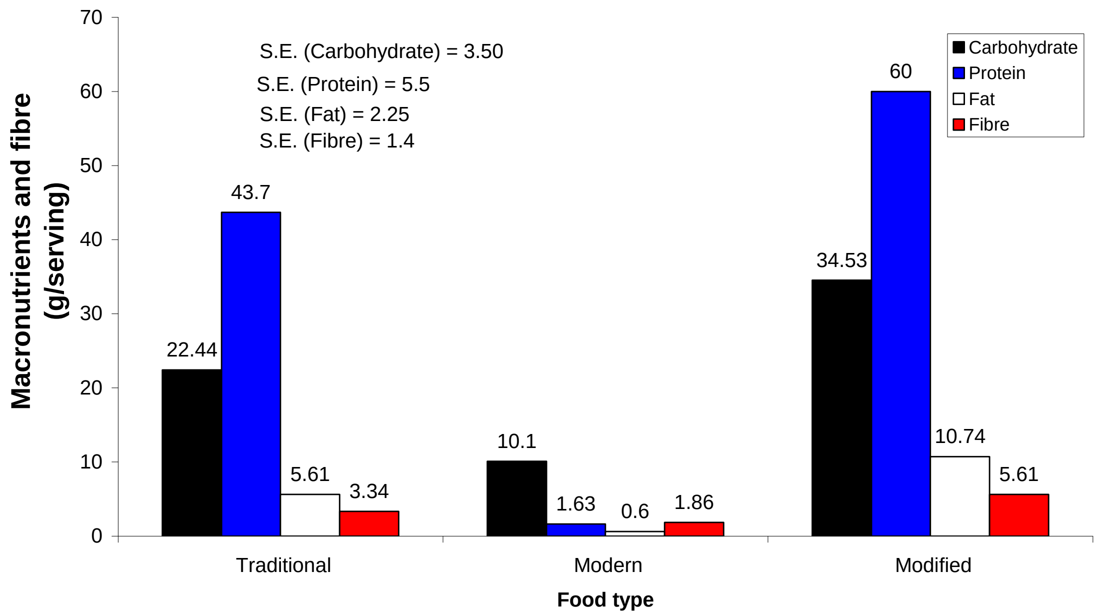

Figure 4.8: Comparison of traditional, modern and modified recipe types in terms of macronutrients (carbohydrate, protein and fat) and fibre contents.

From Table 4.9 and Figure 4.8, it is evident that changes made to traditional foods, such as the addition of oil, fat or spices, increased macronutrients. Hence, modified foods had a higher macronutrient content than traditional foods (Table 4.9). Low levels of macronutrients in modern foods may be due to the absence of modern recipes in the ten most popular recipes. Therefore, because of the small number of recipes for modern foods, it was not possible to conclude that modern recipes have the lowest macronutrients compared with traditional and modified recipes. However, this was not the case for mealie bread, where the modern recipe had the highest nutrients in terms of some of the key nutrients investigated (Table 4.9).

There was a significant negative correlation between modified food popularity and macronutrient content (Figure 4.9). Traditional foods showed a similar trend, albeit not statistically significant (R^2 = 0.53; P = 0.02). Regression analysis of protein, fat and fibre content, respectively, produced no statistically significant results with regard to popularity.

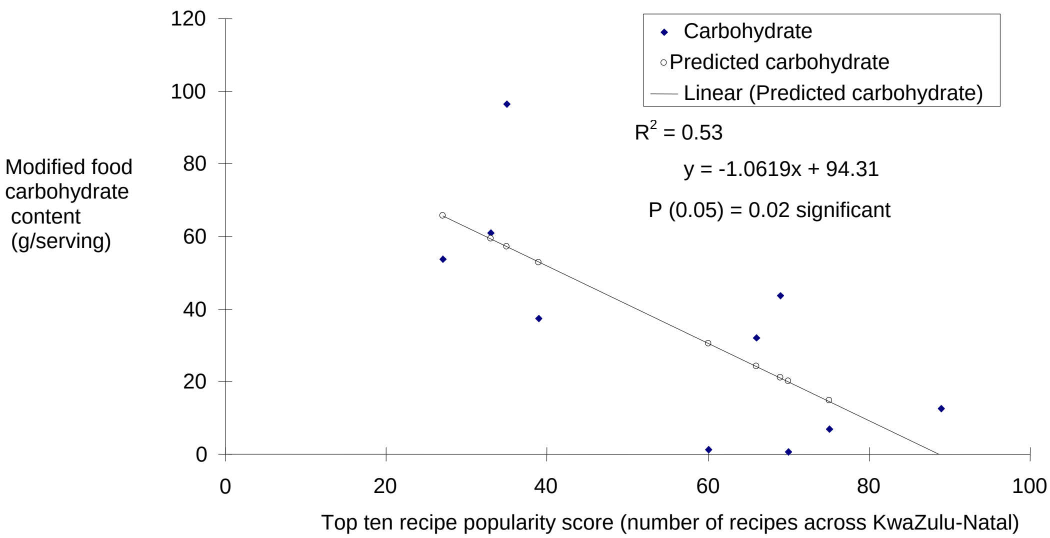

Figure 4.9: Relationship between modified recipe popularity and carbohydrate (CHO) content.

4.3.3 Micronutrients and vitamins

There were significant differences among recipes in terms of micronutrient and vitamin contents (Figures 4.10, 4.11 and 4.12). Vitamin C was highest in *Isijingi*, *isijabane*, *isiphuphutho*, mealie bread and pumpkin leaves (which were not significantly different), wild leafy vegetables and *amahewu* (which were not significantly different) and *umbhaqang*a respectively.

Niacin content was highest in both *umbhaqanga* and traditional African beer, which were not significantly different (Figure 4.10). *Isijabane*, *isijingi*, *isiphuphutho* mealie bread, pumpkin leaves and *amahewu* showed the second highest niacin content, and there was no significant difference among them (Figure 4.10). Vitamin E content was highest in wild leafy vegetables and *umbhaqanga* (which were not significantly different).

Table 4.9 Macronutrient composition of the 10 most popular recipes in the categories traditional, modern and modified, respectively

	Traditional recipe			
Recipe name	Carbohydrates	Proteins	Fat	Fibre
Amahewu	32.46	2.65	1.93	0.99
Biltong	2.72	43.7	1.54	0.35
I*sijabane*	11.22	3.57	3.93	2.83
Isijingi	18.88	1.77	1.21	3.29
Isiphuphutho	25	13.49	17.83	6.92
Mealie bread	16.67	2.7	1.41	2.58
Pumpkin leaves	4.98	5.28	8.47	3.32
Traditional African beer	88.74	21.32	8.42	6.38
Umbhaqanga	19.56	8.54	8.68	5.31
Wild leafy vegetables	4.17	2.23	2.69	1.4
Std deviation	25.18	13.2	5.30	2.23
Std error	5.01	3.6	2.30	1.49
	Modern recipe			
	Carbohydrates	Proteins	Fat	Fibre
Amahewu	-	-	-	-
Biltong	-	-	-	-
I*sijabane*	-	-	-	-
Isijingi	-	-	-	-
Isiphuphutho	-	-	-	-
Mealie bread	100.97	16.33	5.96	18.59
Pumpkin leaves	-	-	-	-
Traditional African beer	-	-	-	-
Umbhaqanga	-	-	-	-
Wild leafy vegetables	-	-	-	-
Std deviation	31.92	5.16	1.88	5.87
Std error	5.65	2.27	1.37	2.42
	Modified recipe			
	Carbohydrates	Proteins	Fat	Fibre
Amahewu	53.6	6.78	3.5	2.4
Biltong	0.71	60	4.19	0.02
I*sijabane*	12.52	2.51	3.14	3.96
Isijingi	61.08	8.33	2.58	7.17
Isiphuphutho	31.99	8.87	8.98	7.75
Mealie bread	43.68	7.36	11.81	5.27
Pumpkin leaves	6.76	1.67	18.62	1.68
Traditional African beer	96.45	26.83	5.33	16.12
Umbhaqanga	37.35	18.37	40.49	10.88
Wild leafy vegetables	1.12	1.45	8.76	0.89
Std deviation	30.76	17.9	11.56	5.02
Std error	5.54	4.2	3.40	2.2

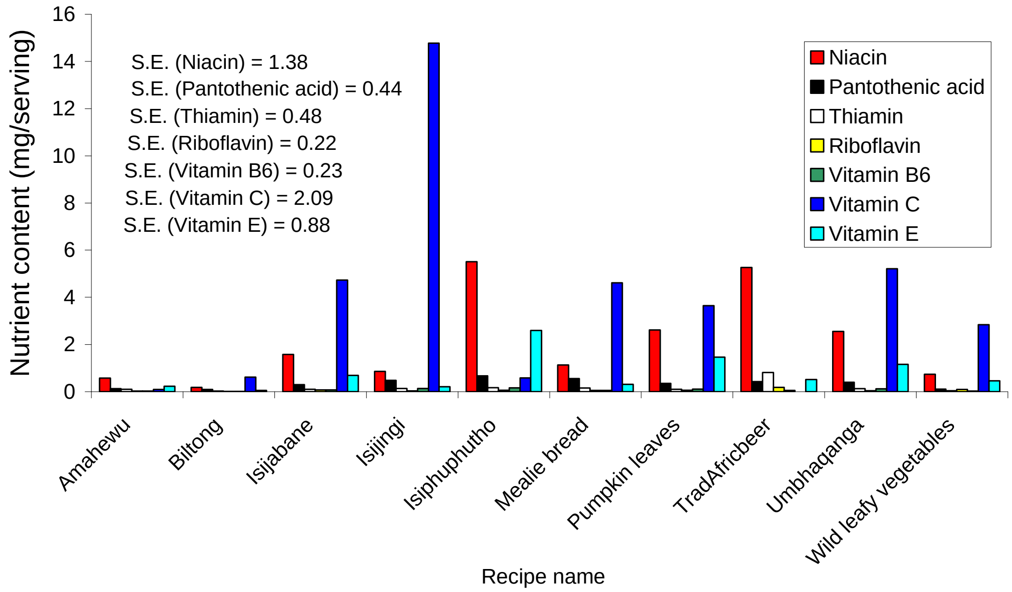

Figure 4.10: Micronutrient and vitamin contents of the 10 most popular recipes submitted.

All the remaining recipes had similar (not significantly different) niacin contents, except for biltong, which had no vitamin B (Figure 4.10). There were small to trace amounts of pantothenic acid, thiamine, riboflavin and vitamin B6 in all the recipes, except for biltong, which had none (Figure 4.10).

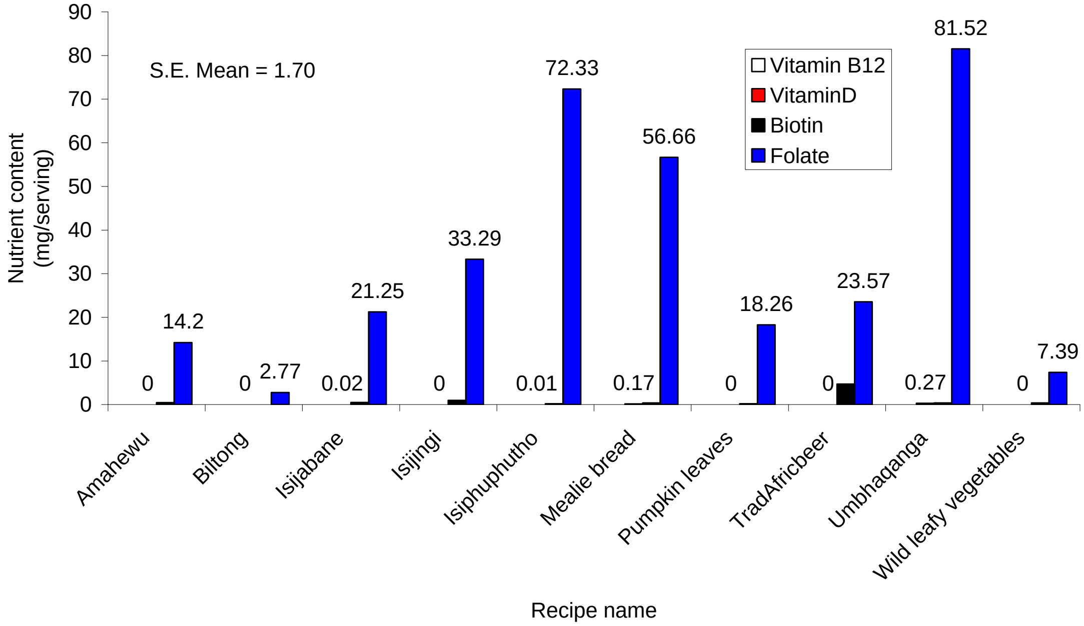

Figure 4.11: Vitamin B12, vitamin D, biotin and folate contents of the 10 most popular recipes submitted.

High levels of folate were found in recipes with high concentrations of bean, *umbhaqanga* and *isiphuphutho*, and the former significantly higher content (Figure 4.14). Mealie bread showed the third highest folate content, followed by *isijingi*, traditional African beer, *isijabane*, pumpkin leaves, *amahewu*, and wild leafy vegetables. As expected, biltong showed no folate content. Small amounts of biotin were found in traditional African beer and *isjingi*, but none was found in other recipes (Figure 4.11). There were traces of vitamin D in all recipes, except biltong, *isiphuphutho* and pumpkin leaves (Figure 4.11).

As expected, the highest amount of vitamin A was found in the pumpkin-based recipes, *isijingi* (Figure 4.12). The second highest vitamin A content was found in *isijabane*, followed, respectively by mealie bread, pumpkin leaves, wild leafy vegetables, *umbhaqanga*, and *isiphuphutho* (Figure 4.12). There trace levels of vitamin A in *amahewu* and biltong (Figure 4.12).

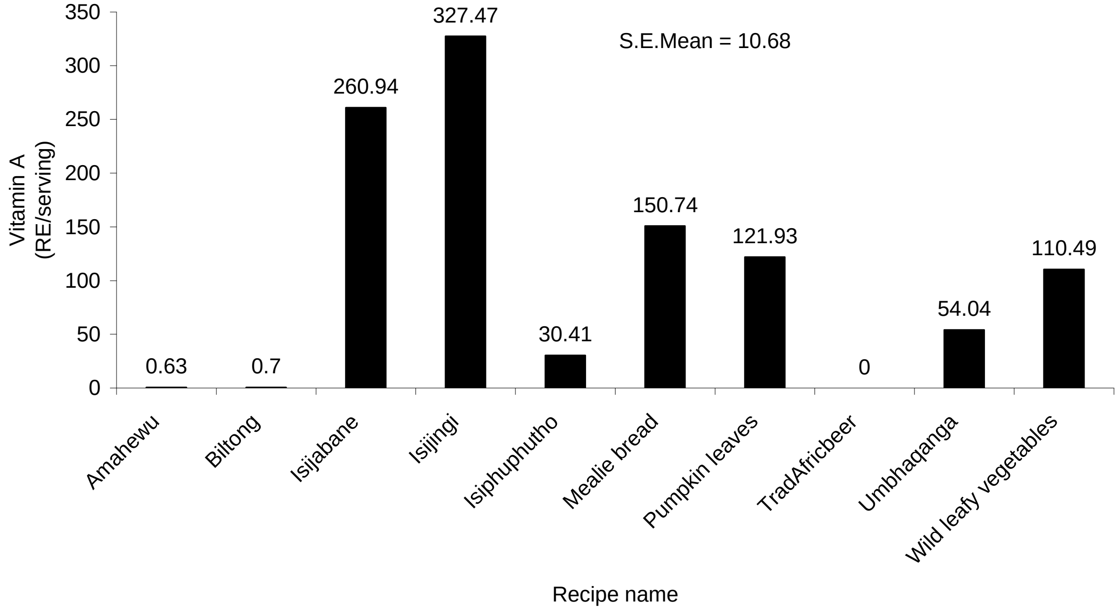

Figure 4.12: Vitamin A content of the 10 most popular recipes submitted.

A comparison of food types showed that the highest micronutrient and vitamin content was in modified foods, followed by traditional and modern foods, respectively (Figures 4.13 and 4.14). This implies that food modification is beneficial in terms of nutritional value. The outcome of a comparison of traditional, modern and modified foods, in terms of other micronutrients, is shown in Table 4.10. Regression analysis showed a significant negative correlation between modified food type popularity and vitamin B6 (Figure 4.15).

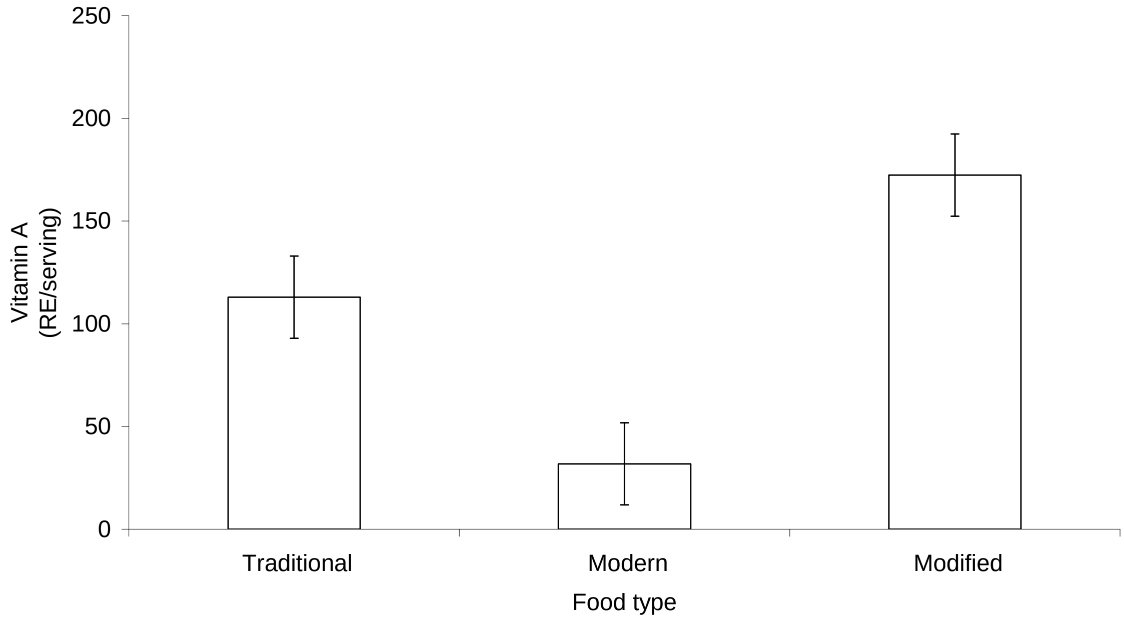

Figure 4.13: Comparison of traditional, modern and modified recipes in terms of vitamin A content.

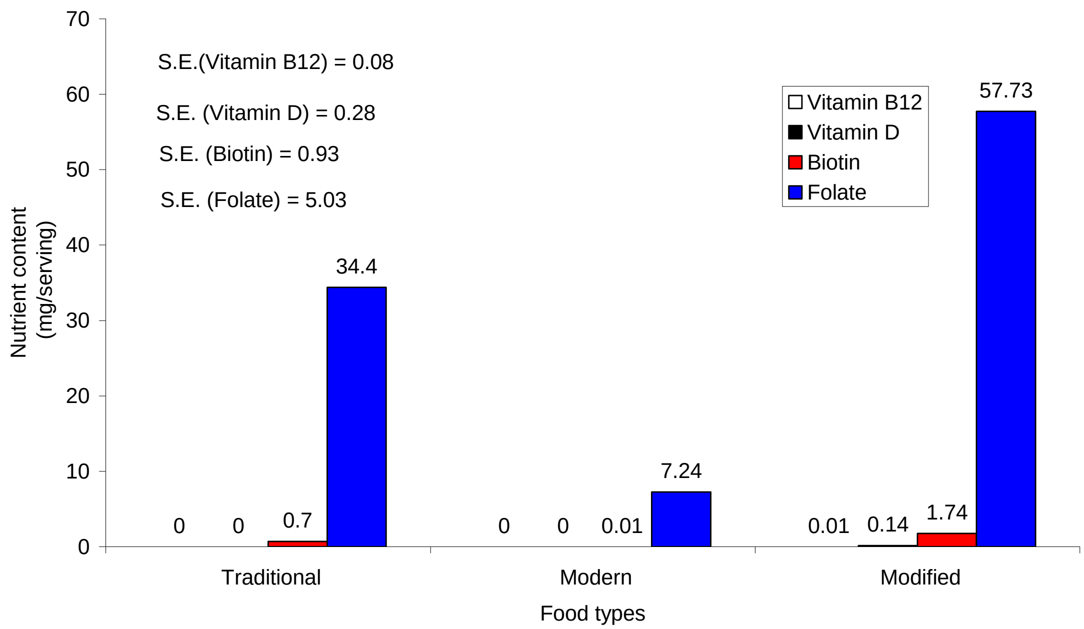

Figure 4.14: Comparison of traditional, modern and modified recipes in terms of vitamin B12 , vitamin D , biotin and folate contents.

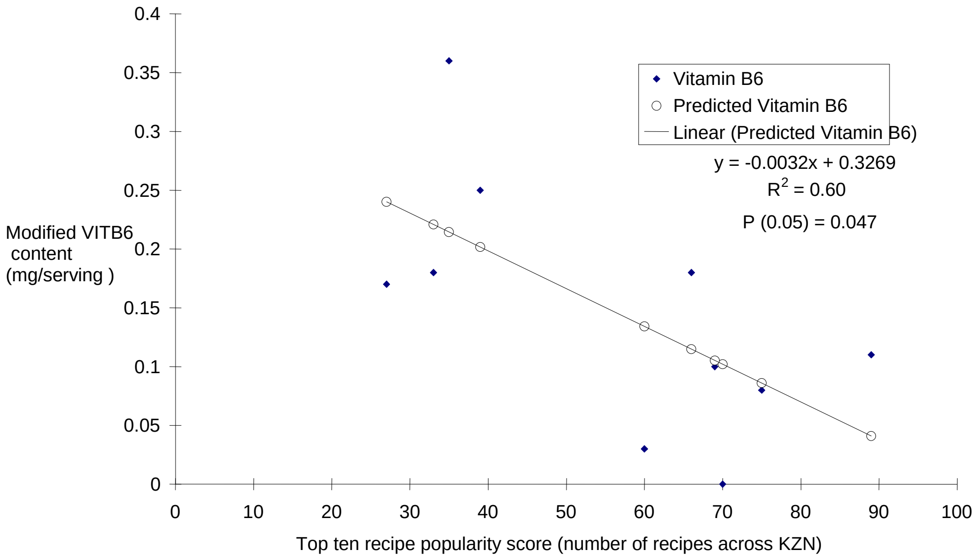

Figure 4.15: Correlation of popularity of the 10 most popular recipes and vitamin B6 (VITB6) in modified food types.

It is evident from this study that significant levels of micronutrients and vitamins were found mainly in recipes made of leafy vegetables, beans and pumpkins. That mealie bread showed significantly high levels of folate may be due to the use of fresh maize in its preparation (Health 24, 2000-2008). As was the case with macronutrients and energy, modifying traditional foods resulted in an increase in their vitamin contents (Table 4.10).

The literature (Chapter 2) shows that there are major deficiencies in vitamins A, B12, C, D and E, and the minerals calcium, iron and zinc in South Africa's rural areas, including KwaZulu-Natal. Table 4.11 shows that six out of 10 modified recipes make a higher contribution to the Estimated Average Requirements (EAR) of vitamin C than their corresponding traditional recipes. As for vitamin E, all the modified recipes make a higher contribution to EAR than the traditional and modern recipes. The results suggest that, in terms of vitamin C and E contents, it would be beneficial to modify traditional recipes. However, it is important to note that some traditional recipes make a higher contribution to the EAR of these vitamins than their corresponding modified recipes. The EAR analysis of vitamins A, B12 and D contributed less than 1% of the ERA per serving.

Table 4.10 Nutritional composition of traditional, modern and modified recipe types for vitamins in the top ten recipes across the province (mg/serving portion)

Recipe name	**Traditional recipes**						
	Niacin	Pantoic acid	Thiamine	Ribloflavin	Vitamin B6	Vitamin C	Vitamin E
Amahewu	0.57	0.13	0.1	0.02	0.02	0.09	0.23
Biltong	0.18	0.09	0.02	0.01	0.01	0.62	0.05
Isijabane	1.58	0.3	0.1	0.08	0.08	4.73	0.69
Isijingi	0.86	0.48	0.14	0.03	0.14	14.77	0.21
Isiphuphutho	5.51	0.67	0.17	0.06	0.16	0.58	2.6
Mealie bread	1.13	0.56	0.15	0.05	0.05	4.61	0.31
Pumpkin leaves	2.61	0.35	0.1	0.06	0.11	3.64	1.47
TradAfricbeer	5.26	0.43	0.81	0.18	0.05	0	0.51
Umbhaqanga	2.55	0.4	0.13	0.04	0.12	5.21	1.16
Wild leafy vegetables	0.74	0.11	0.04	0.09	0.02	2.84	0.46
Std deviation	1.90	0.19	0.22	0.04	0.05	4.38	0.78
Std error	1.38	0.44	0.47	0.22	0.23	2.09	0.88
	Modern recipes						
	Niacin	Pantoic acid	Thiamine	Ribloflavin	Vitamin B6	Vitamin C	Vitamin E
Amahewu	-	-	-	-	-	-	-
Biltong	-	-	-	-	-	-	-
Isijabane	-	-	-	-	-	-	-
Isijingi	-	-	-	-	-	-	-
Isiphuphutho	-	-	-	-	-	-	-
Mealie bread	7.75	0.78	1.03	0.38	0.16	1.57	8.9
Pumpkin leaves	-	-	-	-	-	-	-
TradAfricbeer	-	-	-	-	-	-	-
Umbhaqanga	-	-	-	-	-	-	-
Wild leafy vegetables	-	-	-	-	-	-	-
Std deviation	2.45	0.24	0.32	0.12	0.05	0.49	2.81
Std error	1.56	0.49	0.57	0.34	0.22	0.70	1.67
	Modified recipes						
	Niacin	Pantoic acid	Thiamine	Ribloflavin	Vitamin B6	Vitamin C	Vitamin E
Amahewu	0.91	0.48	0.13	0.1	0.17	3.94	0.39
Biltong	-						
Isijabane	1.42	0.47	0.14	0.1	0.11	11.24	0.89
Isijingi	2.09	0.84	0.29	0.07	0.18	16.68	0.28
Isiphuphutho	2.13	0.6	0.19	0.06	0.18	7.04	2.04
Mealie bread	2.48	1.11	0.29	0.11	0.1	6.57	2.14
Pumpkin leaves	0.66	0.2	0.05	0.03	0.08	7.36	0.67
TradAfricbeer	7	1.48	0.88	0.25	0.36	0	1.68
Umbhaqanga	6.59	0.86	0.27	0.09	0.25	0.97	4.74
Wild leafy vegetables	0.26	0.04	0.01	0.03	0.03	1.76	4.8
Std deviation	2.48	0.47	0.25	0.06	0.10	5.39	1.74
Std error	1.57	0.68	0.50	0.26	0.32	2.32	1.31

Table 4.11 Comparison of recipe types per serving with recommended nutrient intakes

	Percentage of Estimated Average Requirements for adult females of 19 - 30 and 31-50 years *											
	Traditional	**Modern**	**Modified**	**Traditional**	**Modern**	**Modified**	**Traditional**	**Modern**	**Modified**	**Traditional**	**Modern**	**Modified**
	Iron			Zinc			Vitamin C			Vitamin E		
Recipe name	% of EAR			% of EAR			% of EAR			% of EAR		
Traditional African beer	71.97	NA	63.27	56.37	NA	60.11	0.00	NA	0.00	0.00	NA	0.00
Amahewu	4.92	NA	20.74	5.00	NA	8.14	0.16	NA	6.57	0.00	NA	0.00
Biltong	8.18	NA	23.64	25.95	NA	32.34	1.04	NA	0.00	0.00	NA	0.00
Isijabane	21.00	NA	25.10	10.43	NA	7.52	7.89	NA	18.73	0.09	NA	0.33
Isijingi	5.60	NA	17.69	5.21	NA	18.03	24.61	NA	27.79	0.01	NA	0.03
Isiphuphutho	19.99	NA	23.49	41.90	NA	20.97	0.97	NA	11.74	0.00	NA	0.29
Mealie bread	6.39	39.06	13.91	6.01	35.52	15.17	7.68	2.63	10.95	0.00	0.00	4.36
Pumpkin leaves	15.97	NA	8.87	17.58	NA	4.72	6.07	NA	12.26	0.00	NA	0.11
Umbhaqanga	15.98	NA	32.96	24.66	NA	55.25	8.68	NA	1.62	0.20	NA	6.51
Wild leafy vegetables	26.44	NA	13.58	7.68	NA	4.50	4.73	NA	2.93	0.06	NA	0.06

Note: *(Nutrient Information Centre, 2003)
EAR = Estimated average requirement for adult females of 19 - 30 and 31-50 years

(Shaded) Recipe with the highest proportion against the EAR

4.3.4 Mineral nutrients in popular recipes

Nine mineral elements were investigated for occurrence in submitted recipes. On the basis of natural concentrations in plant tissues, five of the mineral elements: calcium, magnesium, potassium, phosphorus and sodium, are regarded as macronutrients, and the other four: copper, iron, zinc and manganese, are referred to as micronutrients (Marschner, 1995; Laboissiére *et al.*, 2000). The occurrence of macro- and micro-nutrients in food follows a similar pattern to that of mineral element occurrence in plant tissue (Figures 4.16 and 4.17).

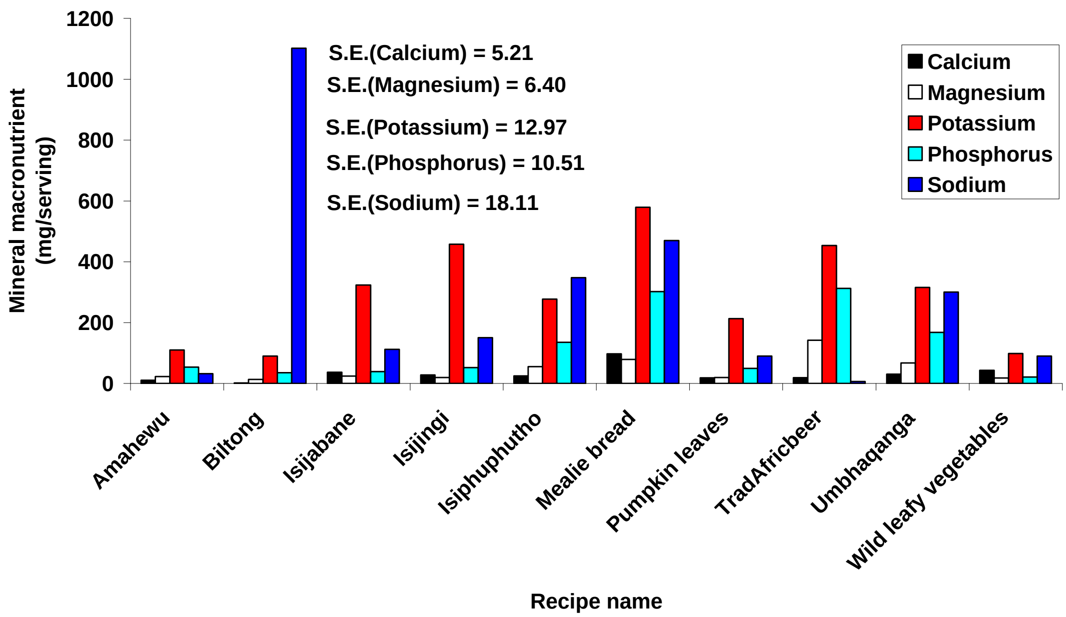

Figure 4.16: Bulk mineral content of the 10 most popular recipes submitted.

Among the macronutrients, sodium concentration was generally the highest in the studied recipes (Figure 4.16). As expected, biltong showed the highest sodium content, most likely because of the extra table salt (NaCl) application for biltong preparation and preservation. The second highest sodium content was found in mealie bread, followed by the bean-based foods *isiphuphutho* and *umbhaqanga*, thereafter *isijabane, isijingi*, pumpkin leaves and wild leafy vegetables (all not significantly different). *Amahewu* showed the lowest Na content (32 mg/serving) (Figure 4.16).

The second most frequently occurring macronutrient was potassium, which occurred in high concentrations in mealie bread, followed by traditional African beer and *isijingi* (Figure 4. 16). The third highest levels of potassium were in *isijabane, isiphuphutho, pumkin leaves* and *umbhaqanga*, which were not significantly different from each other (Figure 4. 16). Pumpkin leaves showed about twice the amount of potassium compared with wild leafy vegetables, suggesting that the former might be a better source of potassium. The amount of potassium in wild leafy vegetables (about 100 mg/serving) was not significantly different from that of traditional African beer and *amahewu* (Figure 4. 16).

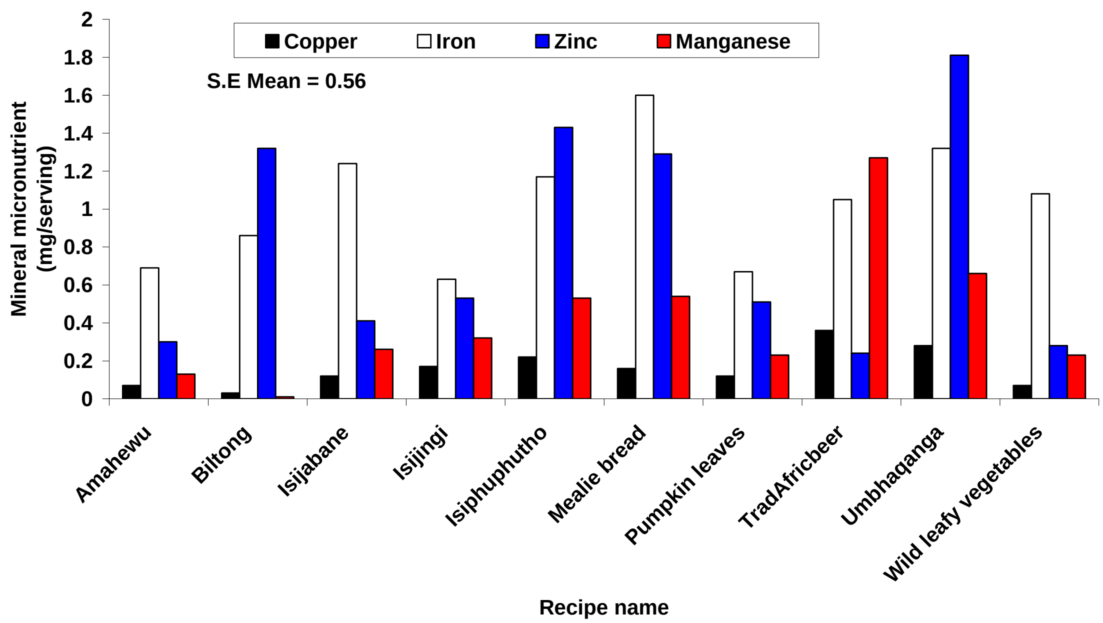

Figure 4.17: Trace mineral content of the 10 most popular recipes submitted.

Mealie bread and traditional African beer were found to be the richest sources of phosphorus among the top ten recipes, containing about 300 mg/100g (Figure 4. 16). *Umbhaqanga* had the second highest phosphorus content (170 mg/serving) followed by *isiphuphutho* (135 mg/100g), *amahewu* (54 mg), *isijingi* (52 mg), pumpkin leaves (50 mg), *isijabane* (39 mg), biltong (36 mg) and wild leafy vegetables (21 mg) respectively (Figure 4.16).

Traditional African beer was the richest source of magnesium among the popular recipes (Figure 4.16). This was followed by mealie bread, *umbhaqanga* and *isiphupthuto*, respectively (Figure 4.16). The remainder of the recipes had about 20 mg/100g of magnesium and there was no significant difference among them, except biltong, which had the lowest magnesium content of about 13 mg/serving.

Calcium was found mainly in mealie bread (approximately 100 mg/serving) (Figure 4.16) Wild leafy vegetables followed mealie bread with 43 mg, and *isijabane*, which is made of wild leafy vegetables and maize meal, showed 37 mg/serving (Figure 4.16). The bean and maize recipes, *isiphuphutho* and *umbhaqanga*, were not significantly different in terms of calcium content (25 and 30 mg, respectively). Pumpkin leaves and traditional African beer showed about 18 mg/serving of calcium, *amahewu* showed about 10 mg/serving, and biltong had no calcium in it (Figure 4.16).

Zinc and iron were the predominant micronutrient minerals in the popular recipes of KwaZulu-Natal (Figure 4.17). The recipes that were made mainly of beans, *umbhaqanga* and *isiphuphutho*, showed a significantly high Zinc content, the highest levels being in *umbhaqanga* (Figure 4.17). The amount of Zinc in *isiphuphutho* (about 1.35 mg/serving) was not significantly different from that found in mealie bread and biltong (Figure 4.17). Pumpkin leaves and *isijingi* (made of pumpkin fruit flesh and maize meal) were not significantly different in terms of Zinc content (~ 0.5 mg/serving) (Figure 4.17). *Isijabane* (wild leafy vegetables and maize meal) showed a significantly higher Zinc content than wild leafy vegetables on their own, and the latter were not significantly different from *amahewu* and traditional African beer (Figure 4.17).

The highest amount of iron (1.6 mg/serving) among the popular recipes of KwaZulu-Natal was found in mealie bread (Figure 4.17). *Isijabane, isiphuphutho* and *umbhaqanga* were not significantly different from one another in terms of Fe content (ca. 1.2 mg/serving) but they were better than traditional African beer and biltong (~ 1 mg/serving), which were better than *amahewu, isijingi* and pumpkin leaves (~ 0.7 mg/serving) (Figure 4.17).

There was a significantly high content (1.27 mg/serving) of manganese in traditional African beer compared with other recipes (Figure 4.17). *Umbhaqanga* had about 50% less manganese content than traditional African beer. *Isiphuphutho* and mealie bread had equal amounts (about 0.5 mg/serving) of manganese. *Isijingi* had a higher manganese content (0.32) than *isijabane*, pumpkin leaves and wild leafy vegetables, which had about 0.25 mg/serving (Figure 4.17). *Amahewu* had a very low manganese content (about 0.1 mg/serving) and biltong only had traces of manganese (0.01 mg/serving) (Figure 4.17).

Significant levels of copper were found in traditional African beer (0.36 mg/serving) and the bean-based foods, *isiphuphutho* and *umbhaqanga*, had between 20 and 30 mg/serving of copper. *Isijabane*, *isijingi*, mealie bread and pumpkin leaves did not significantly differ in terms of copper content, but they had more copper than *amahewu*, wild leafy vegetables and biltong (Figure 4.17).

The determination of differences between traditional, modern and modified recipes showed that changing food from traditional to modified was generally associated with an increase in mineral content (Figure 4.18 and Tables 4.11 and 4.12). Changing a traditional recipe to a modern recipe was generally associated with a decrease in mineral content (Figure 4.18) that is, modified recipes had higher mineral content, followed by traditional and modern foods, respectively.

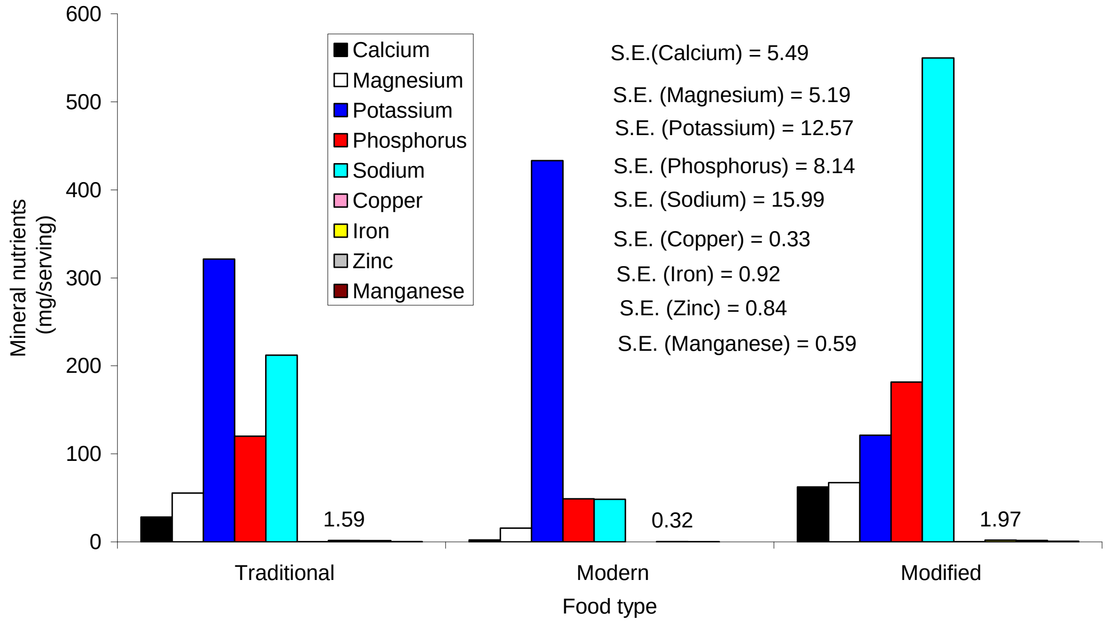

Figure 4.18: Comparison of traditional, modern and modified foods in terms of mineral content.

A closer observation of individual minerals showed that traditional food modification was associated with about 66% decrease in potassium content (Figure 4.18). The modernisation of traditional food has had the opposite effect to that of modification, meaning that modification is not beneficial. There was about 35% increase in potassium and about 77% decrease in sodium when traditional food was modernised (Figure 4.18).

Tables 4.11 shows that, generally, modified recipes made a higher contribution to the EAR of iron than traditional recipes. As for zinc, 50% of the traditional recipes made higher contribution to EAR than the corresponding modified recipes, and 50% of the traditional recipes make a lower contribution to the EAR than their corresponding modified recipes. Of the modern recipes, only mealie bread was amongst the top 10 recipes and it makes a higher contribution to the EARs of iron and zinc than both the traditional and modified mealie breads. Only mealie bread had a modern equivalent among the 10 popular recipes and made a higher contribution to the EARs of iron and zinc than both the traditional and modified mealie breads. The results suggest that, in terms of iron content, it is generally beneficial to modify the traditional recipes, while with respect to zinc, modification of the recipes may be either beneficial or detrimental.

The modern mealie bread is of superior quality, especially with regard to iron and zinc content. The reason for this was suggested earlier. This may be due to the addition of fortified flour.

Table 4. 12 Nutritional compositions of traditional, modern and modified recipe types for minerals (mg/serving portion) in the top ten recipes across all regions of KwaZulu-Natal

Recipe name	Traditional recipes								
	Calcium	**Magnesium**	**Potassium**	**Phosphorus**	**Sodium**	**Copper**	**Iron**	**Zinc**	**Manganese**
Amahewu	26.36	22.67	78.3	51.47	18.43	0.05	0.4	0.34	0.08
Biltong	1.39	11.28	82.73	32.97	736.57	0.03	0.66	1.76	0.02
Isijabane	49.24	38.87	380.18	66.99	180.32	0.18	1.7	0.71	0.33
Isijingi	20.54	16.76	520.93	34.24	7.36	0.12	0.45	0.35	0.25
Isiphuphutho	44.37	96.68	413.09	244.8	470.3	0.48	1.62	2.85	0.97
Mealie bread	7.31	25.03	175.21	76.23	167.63	0.06	0.52	0.41	0.15
Pumpkin leaves	31.24	43.87	409.16	112.13	102.23	0.28	1.29	1.2	0.51
Traditional African beer	24.48	195.24	630.72	391.23	8.61	0.58	5.83	3.83	0.25
Umbhaqanga	28.82	64.74	315.7	157.73	351.23	0.26	1.29	1.68	0.62
Wild leafy vegetables	72.22	35.37	206.42	34.14	79.79	0.14	2.14	0.52	0.29
Std deviation	20.61	55.36	184.31	116.59	239.09	0.18	1.60	1.18	0.28
Std error	4.54	7.44	13.57	10.79	15.46	0.43	1.26	1.08	0.53
	Modern recipe								
	Calcium	**Magnesium**	**Potassium**	**Phosphorus**	**Sodium**	**Copper**	**Iron**	**Zinc**	**Manganese**
Amahewu	-	-	-	-	-	-	-	-	-
Biltong	-	-	-	-	-	-	-	-	-
Isijabane	-	-	-	-	-	-	-	-	-
Isijingi	-	-	-	-	-	-	-	-	-
Isiphuphutho	-	-	-	-	-	-	-	-	-
Mealie bread	23.17	158.4	1210.62	489.66	483.06	0.27	3.16	2.42	1.04
Pumpkin leaves	-	-	-	-	-	-	-	-	-
Traditional African beer	-	-	-	-	-	-	-	-	-
Umbhaqanga	-	-	-	-	-	-	-	-	-
Wild leafy vegetables	-	-	-	-	-	-	-	-	-
Std deviation	7.32	50.09	382.83	154.84	152.75	0.08	0.99	0.76	0.32
Std error	2.70	7.07	19.56	12.44	12.35	0.29	0.99	0.87	0.57
	Modified recipes								
	Calcium	**Magnesium**	**Potassium**	**Phosphorus**	**Sodium**	**Copper**	**Iron**	**Zinc**	**Manganese**
Amahewu	29.15	45.6	252.07	110.48	77.23	0.15	1.68	0.55	0.32
Biltong	4.05	28.08	187.39	73.73	2568.07	0.07	1.92	2.2	0
Isijabane	61.38	34.48	590.37	50.89	155.79	0.17	2.04	0.51	0.45
Isijingi	62.72	41.89	850.75	122.67	443.78	0.39	1.43	1.23	0.7
Isiphuphutho	30.94	69.24	419	159.88	573.23	0.16	1.9	1.43	0.63
Mealie bread	261.24	52.47	350.3	340.97	759.86	0.16	1.13	1.03	0.41
Pumpkin leaves	22.99	14.39	231.08	36.74	168.82	0.09	0.72	0.32	0.18
Traditional African beer	32.5	231.25	729.48	545.83	10.83	0.5	5.15	4.09	3.57
Umbhaqanga	62.9	138.78	632.45	346.04	550.99	0.58	2.67	3.76	1.36
Wild leafy vegetables	56.78	18.03	88.37	29	190.21	0.07	1.1	0.31	0.38
Std deviation	72.66	67.63	255.29	172.27	750.76	0.18	1.24	1.38	1.03
Std error	8.52	8.22	15.97	13.12	27.40	0.43	1.11	1.17	1.01

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

As stated earlier, although it is known that the diet of people in rural KwaZulu-Natal is diverse, there are limited data on the composition of traditional recipes and even less is known of the impact of modernisation of these traditional recipes on their nutritional values. Modification of the traditional recipes may be, with respect to nutritional quality, beneficial or detrimental, depending on the nature of the modification. The aim of this study was to determine the popularity and comparative nutritional quality of recipes used in rural KwaZulu-Natal.

Recipes from the eleven districts of KwaZulu-Natal that were submitted to a “Traditional Food Recipe Competition” were evaluated. A total of 1200 recipes were submitted for the competition. The recipes included traditional, modified and modern types. The recipe data were analysed statistically to determine recipe distribution, popularity and the relationships between food popularity and gender preference, and popularity and nutritional value. The nutritional value of the recipes and their contribution to Estimated Average Requirements (EARs) of most deficiency-prone nutrients was analysed using published Food Composition Tables.

The findings of this study showed that traditional recipe types were the most popular submissions and were used largely in rural KwaZulu-Natal. Of a total of 1 200 recipes submitted, the top 10 recipes, listed in order of decreasing popularity, are *isijabane*, pumpkin leaves, biltong, *isiphuphutho*, mealie bread, wild leafy vegetables, *umbhaqanga*, traditional beer, *isijingi* and *amahewu*. From these 10 top recipes (n = 563), 72% (405) are traditional, 27% (152) are modified and 0.2 % (1) are modern recipes. Districts where there are big towns tended to have lower submissions of traditional recipes. However, the findings of this study clearly show that people of KwaZulu-Natal still use traditional foods to a large extent (68% of 1200); they use conventional food crops and industrial condiments, so that traditional food is significantly (25%) modified. Females predominantly make traditional foods and to a less extent than males modify traditional foods. An interesting finding of this study was the lack of relationship between food type or recipe popularity and its apparent ease to make. For example, the most popular recipe, *isijabane,* is characterised by ingredients that are not readily available (a variety of wild leafy vegetables, course maize flour, which requires traditional mortar and pestle to make, water and some table salt). On the contrary, *amahewu* ingredients are maize meal, water and some table salt, which appear to be readily available, but *amahewu* were the least popular recipe. It is possible that popularity is related to a complex number of factors, but this study could not explain those factors. A complex of socio-economic factors may be influencing recipe modification.

Recipe modification generally resulted in an improvement in nutritional value, although in some cases the modified recipe would be unhealthy as it had high fat and/or salt content. In some cases, the modification of a traditional recipe did not improve its nutritional value to the extent of significantly increasing its contribution to the EARs of the deficiency-prone nutrients. The findings on the mineral content of traditional, modern and modified foods suggest that preparation methods can have a significant effect on the mineral content of foods. Since the major source of sodium in food is table salt, it can be deduced that traditional food preparations involve higher levels of table salt compared with modern and modified food preparation. It was noteworthy that the micro-nutrients of particular importance in children and women's health (Vitamin A, Fe and Ca) occur in reasonably high concentrations in traditional foods. Although the findings of the study indicated that, generally, there was no relationship between nutritional value and food popularity, it was clear that *isijabane*, the most popular recipe, is a major source Fe, Ca, Vitamin A and Vitamin C, whereas, *amahewu,* the least popular recipe was generally low in these nutrients, but was a major source of carbohydrates. In conclusion, modified foods had higher nutrient contents than traditional and modern foods. There was a negative correlation between food popularity and nutrient content, suggesting that popular foods were not necessarily the most nutritious. It was concluded that the people of KwaZulu-Natal simultaneously use traditional, modified and modern recipes, but that there is a shift towards food modification through use of non-indigenous crops and modern ingredients.

It is recommended that the people of KwaZulu-Natal consider adopting modified recipes only if the modified recipe has a significant contribution to the EARs of the deficiency-prone nutrients. However, in cases whereby, as shown in this study, modification of a traditional recipe would result in it being unhealthy, e.g. due to a high fat and/or salt content, it is recommended that the traditional recipe be maintained.

It is recommended that policy makers disseminate information on the occurrence of three major categories of recipe types, traditional, modified and modern. Information on the general relative merits, particularly with respect to nutritional quality, should be disseminated in simple communication language. In general the policy makers are recommended to promote the maintenance of the traditional recipes, but encourage a shift to the modified recipes where it would be nutritionally justified as explained above. As mentioned earlier, the results of this study indicated that there is generally a low use of traditional recipes by the youths. Policy makers could promote modification of recipes that contain nutritious traditional ingredients so that the youths can also benefit nutritionally and at the same time be conscientised of their traditional dietary background. Examples of such a modification would be mixing flour with wild edible vegetables when making muffins (e.g. blackjack muffins) or cakes; adding wild edible vegetables or any other traditional foods as fillings in pies and bunny chows; using *amadumbe* as toppings on pizza. Substituting conventional vegetables (e.g. spinach) with a wild vegetable (e.g. *amaranthus*) in recipes or mixing wild leafy vegetables with conventional leafy vegetables could increase nutrient content of the recipes, for example, lettuce in a sandwich could sometimes be replaced with wild mustard). Adding wild leafy vegetables in green salads could also improve the nutrient value of the salads.

The reasons for choice of recipes by people of different socio-economic status should be investigated. The data thereof would help to understand whether culture, access to resources (ingredients), income, and levels of education, among others, influence the type of food that people chose. Further research should investigate the effects of changing recipe types from traditional to modified and modern types on the other quality attributes, including sensory and storage quality.

Future studies like the current one should be planned carefully such that the quantities of all ingredients are included, which would improve the accuracy of nutritional analysis. The traditional foods recipe questionnaire needs to be improved to collect more detailed data on such parameters as participant’s incomes and education, and the frequency of use of the recipes.

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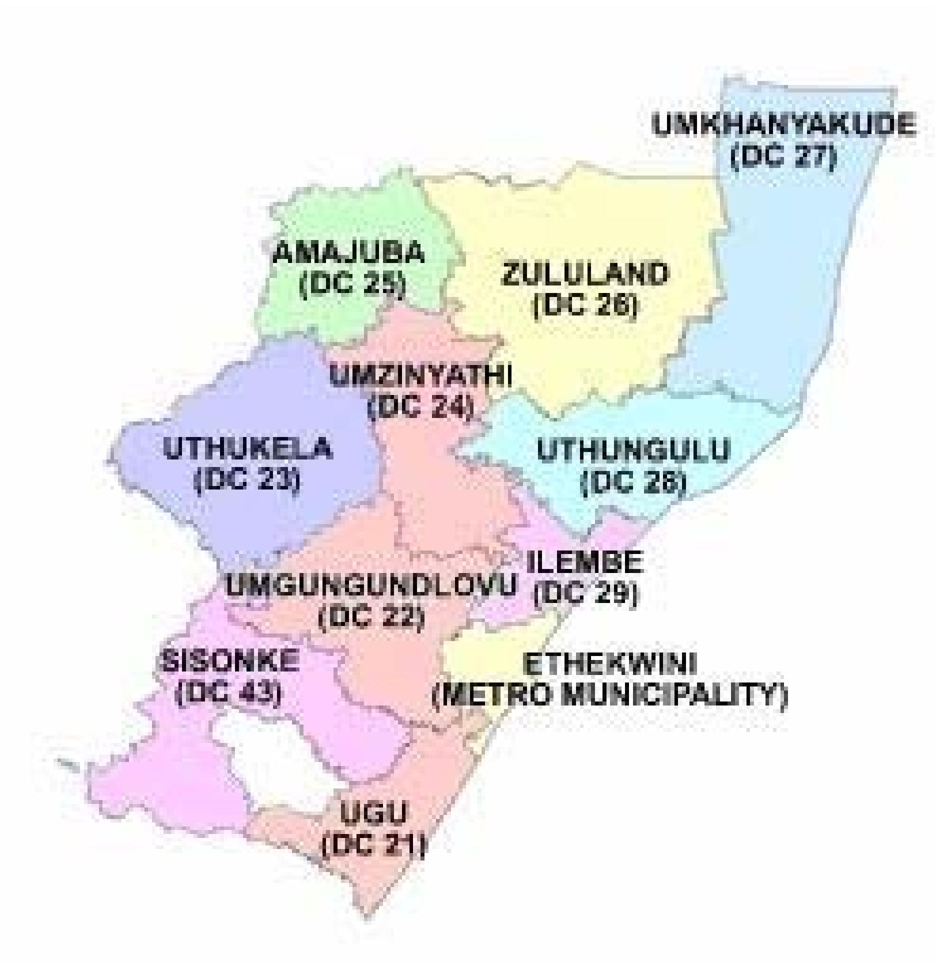
Appendix A KwaZulu-Natal districts (KwaZulu-Natal Department of Transport, 2005).



Appendix B Information about the 2005 traditional food competition of the Department of KwaZulu-Natal Department of Agriculture and Environmental Affairs (KwaZulu-Natal Department of Agriculture and Environmental Affairs, 2005)

KZN Agriculture and Environmental Affairs
Address : Embassy Building
_______________Ministry_____________
P.O.Box 2132 Durban, 4000 Enquiries: Tel: 031 – 368-2223
Fax: 031 – 368-1601 Ref: traditional recipe book E-mail:
mbulelo.baloyi@dae.kzntl.gov.za Date: 26 July 2007
uMnyango: weZolimo neZemvelo
ISIFUNDAZWE SAKWAZULU-NATALI

A Traditional Food competition was held during 2005 with several goals in mind, namely to create awareness amongst the departmental staff and the community.

The competition was also aimed at encouraging the youth to go back to the elderly to find out about their traditional dishes; and to gather a wide range of recipes that could be tested and if necessary adapted by the Value Adding Section of the Department's Agricultural Development Support Services (ADSS) to be compiled into a KwaZulu-Natal Traditional Food Recipe Book.

This competition sparked the interest in traditional foods throughout KwaZulu-Natal, resulting in many catering companies adding traditional dishes to their menus, and the Department of Correctional Services requesting the Department of Agriculture and Environmental Affairs to assist them in running a similar competition within their correctional facilities, which happened during 2006.

Appendix C Population statistics for KwaZulu-Natal Regions.

(Stats SA, 2004).

District	Population
Ethekwini	3 090 000
Umgungundlovu	928 000
Uthungulu	886 000
Zululand	804 000
Ugu	704 000
Uthukela	657 000
Umkhanyakude	573 000
Ilembe	560 000
Amajuba	468 000
Umzinyathi	456 000
Sisonke	298 000

Appendix D Submitted recipes across all regions of KwaZulu-Natal, ranked by the number of entries

Recipe name	No of recipes submitted
Isijabane	89
Pumpkin leaves	75
Billtong	70
Mealie bread	69
Isiphuphutho	66
Wild leafy vegetables	60
Umbhaqanga	39
African traditional beer	35
Isijingi	33
Amahewu	27
Ugume/ukhothe (mealie powder)	21
Chicken	20
Peach preservation	18
Mealies and bambara groundnuts(Izinkobe zezindlubu)	16
Samp and beans	16
Umbhuqwa	15
Isithwalaphishi	14
Izinkobe (cooked mealies)	14
Ujeqe	11
Umcaba	11
Beans	11
Idokwe	11
Samp	10
Inqeke (Pumpkin)	9
Pumpkin	9
Spinach	8
Dried fruit	7
Putu	7
Trifle	7
Lemon juice	6
Mealies	6
Offal	6
Potatoes	6
Bambara groundnuts	6
Meat	5
Peanuts	5
Sweetpotato	5
Amaqebengwana	4

Appendix D (continued)

Recipe name	No of recipes submitted
Amasi omcaba	4
Bread	4
Dried amaranthus	4
Dumplings	4
Fish	4
Idokwe lamaviyo	4
Isigwaqana	4
Mealies and maas	4
Mealies and peanuts	4
Mealies preservation	4
Popcorns	4
Porridge	4
Roasted mealies	4
Sorghum porride	4
Uhlelenjwayo	4
Amadumbe	4
Dried vegetables	3
Guava	3
Ifusazana	3
Maize porridge	3
Maize presevation	3
Mealies and cowpeas	3
Pie	3
Roasted peanuts	3
Umnyalankobe	3
Amadangane and chicken	2
Beef curry	2
Butternut	2
Dried fish	2
Dried mealies	2
Dried pumpkin leaves	2
Fish preservation	2
Fried fish	2
Fruit punch	2
Fruit salad	2
Green mealies preservation	2
Ground mealies and maas	2
Guavas (jam)	2
Idokwe lamabele	2
Ifocela	2
Ifutho	2

Appendix D (continued)

Recipe name	**No of recipes submitted**
Isancobe (green mealies preservation)	2
Isidlakadla	2
Isidlwadlwa	2
Isinyalankobe	2
Isiqhum-qhum	2
Marula drink	2
Mealies and isambasamba	2
Meat and dumplings	2
Meat stew	2
Mixed vegetables	2
Pumpkin preservation	2
Pumpkin seeds	2
Samp and bambara groundnuts	2
Soup	2
Sweet potato chips	2
Traditional snack	2
Ugedle (roasted mealies)	2
Umbhushu	2
Umkhupha	2
Umkhwili	2
Umxhafela	2
Vegetable preservation	2
Vegetables	2
Wild melon jam	2
Yorghut	2
Maize stiff porridge	2
Ababanzana	1
Amabhajiya	1
Amadade	1
Amadumbe snacks	1
Amagadangane	1
Amahlala	1
Amakhathini	1
Amantulwa drink	1
Amaranths	1
Amaranths fatcakes	1
Amaviyo	1
Amaviyo drink/Amatutu	1
Apples	1
Avocado with mealies	1
Baby marrows and peanuts	1

Appendix D (Continued)

Recipe name	No of recipes submitted
Baked butternut	1
Bambara groundnuts and peanuts	1
Bambara meal	1
Bean curry	1
Bean soup	1
Beans (uncooked) green, dehydrated	1
Beans and bones stew	1
Beef	1
Beef bones	1
Beef curry	1
Beetroot salad	1
Boiled chicken	1
Boiled meat	1
Butternut and peanuts	1
Cabbage	1
Cabbage and carrot	1
Calabash	1
Cane juice	1
Carrots	1
Carrots with garlic	1
Chicken and green mealies dumplings	1
Chicken and vegatable casserole	1
Chicken stew	1
Chicken-free range	1
Cooked and roasted mealies	1
Cooked ground mealies	1
Cooked mealies	1
Cowpeas preservation	1
Dried mixed vegetables(carrots, cabbage, red pepper)	1
Dried onion	1
Dried potatoes	1
Dumpling and offal	1
Dumplings and chicken	1
Dumplings in tripe and vegetables	1
Fish pie	1
Fried chicken	1
Fried peanuts	1
Fried potatoes	1
Fruit preservation, cooked	1
Fruit skewers	1
Grape juice	1
Green beans with garlic and mushrooms	1

Appendix D (continued)

Recipe name	**No of recipes submitted**
Green mealies pie	1
Guava juice	1
Guava preservation	1
Ibhece	1
Ibhece jam	1
Ihongo	1
Ijikijolo	1
Imbamba	1
Imbasa	1
Imbasha (traditional popcorn)	1
Imbube	1
Imfulamfula	1
Imifino fritters	1
Incumbe	1
Inhlokoshama/traditional drink	1
Injemane	1
Name of Recipe	1
Intshaqane	1
Isichumuchumu	1
Isicukwane	1
Isighobe samazambane	1
Isihuluhulu	1
Isinyabulala nenqeke yethanga	1
Isinyambane	1
Isiphuphe sezindlubu	1
Isiphushela	1
Isiqaba	1
Isiqhumqhumane	1
Isiqwaqwane	1
Isishanyula	1
Isishosholongwane	1
Isitshuku sikabhontshisi	1
Iswele	1
Iyambazi (porridge)	1
Iziqunga	1
Juice	1
Lemon cream	1
Maas and sorghum	1
Maize and sorghum	1
Maize corn	1

Appendix D (continued)

Recipe name	**No of recipes submitted**
Maize meal cake	1
Maize rice	1
Mango sauce	1
Mashed potatoes	1
Mealie porridge with soya beans	1
Mealies (ground) and cowpeas	1
Mealies and beans with mince meat	1
Mealies and maize meal	1
Mealies and polony	1
Mealies and potatoes	1
Mealies and pumpkin	1
Mealies and rabbit	1
Mealies seeds	1
Mealies with bambara groundnuts and cowpeas	1
Mince balls	1
Mushrooms and potatoes	1
Noname	1
Nut and milk flavoured drink	1
Offal and dumplings	1
Orange juice	1
Peanut brittle (sweet)	1
Peanuts and mealies	1
Pineapple beer	1
Pineapple mahewu	1
Plain juice (water and sugar)	1
Potato snack	1
Potatoes and maize meal	1
Preserved guava	1
Preserved pumpkin leaves	1
Pumkin leaves	1
Pumpkin drink	1
Pumpkin fatcake	1
Pumpkin jam	1
Rhemela drink	1
Samp and fish	1
Samp and meat	1
Samp and peanuts	1
Samp stew	1
Sorghum	1

Appendix D (Continued)

Recipe name	**No of recipes submitted**
Sorghum and maas	1
Sorghum beer	1
Sorghum drink/porridge	1
Sorghum dumplings	1
Sorghum juice	1
Sorghum with chicken	1
Soya biscuits	1
Soya bread	1
Spiced pumpkin	1
Steamed sweet potato pudding	1
Sweet potato wafers	1
Sweet potato with offal	1
Sweetpotato juice	1
Taro bread	1
Tasty beef	1
Tomato soup	1
Tomatoes and carrots	1
Traditional chicken	1
Traditional drink	1
Ubhadla	1
Ujuzi wezimunyane	1
Umacasha ebhodweni	1
Umganandoda	1
Umkhumuzo	1
Umkhupha Impama	1
Umkhupha wenyama	1
Umkhupha wesiZulu	1
Umkhupha wombila	1
Umvubo	1
Umwali	1
Untshobelo	1
Vegetable soup	1
Vegetable stew	1
Vegetables preservation	1
Wild melon (ibhece)	1
Zulu traditional juice	1
Zulu wine	1

Appendix E Raw data sorted for analysis of nutrients

Recipe type	Recipe name	ENERGY	PROT	CHO	FIBRE	FAT	CA	FE	MG	P	K	NA	ZN
Traditional	TradAfricbeer	3370.061	21.3187	88.74	6.382667	8.419753	24.48101	5.8295	195.2439	391.2266	630.7204	8.611313	3.833269
Traditional	Amahewu	592.7952	2.65381	32.45794	0.991857	1.925532	2.357381	0.398683	22.6727	51.47087	78.3	18.43135	0.339867
Traditional	Biltong	170.755	43.7	2.72355	0.349876	1.53629	1.393044	0.662955	11.2797	32.96863	82.73363	736.5712	1.764366
Traditional	Isijabane	397.7131	3.574772	11.21661	2.825043	3.930632	49.24487	1.700906	38.866	66.99251	380.1812	180.3157	0.709238
Traditional	Isijingi	398.1226	1.774653	18.8761	3.286386	1.208368	20.54126	0.453913	16.763	34.26258	520.9255	7.35772	0.35429
Traditional	Isiphuphutho	1333.264	13.4904	25.00125	6.915173	17.83286	44.37438	1.618958	96.67638	244.7957	413.0948	470.2987	2.849321
Traditional	Mealie bread	364.6804	2.704802	16.67202	2.57837	1.410392	7.306173	0.517877	25.03451	76.22821	175.2059	167.6292	0.408718
Traditional	Pumpkin leaves	496.209	5.277724	4.976581	3.321394	8.47208	31.23889	1.293897	43.87236	112.1263	409.155	102.2271	1.195537
Traditional	Umbhaqanga	879.2226	8.538138	19.56071	5.305291	8.682547	28.81607	1.294725	64.74452	157.7326	315.6985	351.2309	1.676792
Traditional	Wild leavy vegetables	198.4262	2.228225	4.167743	1.397117	2.685187	72.22039	2.14176	35.37459	34.13848	206.4174	79.78523	0.522429
Modern	TradAfricbeer	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Amahewu	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Biltong	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Isijabane	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Isijingi	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Isiphuphutho	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Mealie bread	2168.53	16.33	100.969	18.594	5.958	23.17	3.164	158.4	489.66	1210.62	483.06	2.4153
Modern	Pumpkin leaves	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Umbhaqanga	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Wild leavy vegetables	0	0	0	0	0	0	0	0	0	0	0	0
Modified	TradAfricbeer	3862.083	26.83333	96.45	16.125	5.334766	32.5	5.125	231.25	545.8333	729.5833	10.83333	4.0875
Modified	Amahewu	1104.458	6.78	53.59622	2.396056	3.504206	29.14611	1.68	45.60278	110.4792	252.0697	77.22639	0.553628
Modified	Biltong	377.5751	60	0.710978	0.021667	4.185304	4.048333	1.915089	28.07556	73.72778	187.395	2568.072	2.199211
Modified	Isijabane	391.8275	2.505802	12.51945	3.955029	3.141297	61.38333	2.033339	34.47807	50.88555	590.3715	155.7942	0.511109
Modified	Isijingi	1263.465	8.3305	61.07725	7.173	2.583166	62.72167	1.43275	41.89167	122.665	850.7542	443.7767	1.225717
Modified	Isiphuphutho	1053.92	8.869712	31.99438	7.753061	8.982203	30.94295	1.903061	69.23682	159.8795	418.9991	573.2315	1.425885
Modified	Mealie bread	1271.821	7.355385	43.67515	5.274843	11.81346	261.2435	1.126667	52.4748	340.9708	350.3042	759.8596	1.031492
Modified	Pumpkin leaves	240.2674	1.666665	6.764059	1.679802	18.622	22.99271	0.718162	14.38825	36.74202	231.0756	168.8172	0.321087
Modified	Umbhaqanga	2510.836	18.36746	37.35096	10.88146	40.48878	62.8975	2.669625	138.785	346.0379	632.4508	550.9896	3.757233
Modified	Wild leavy vegetables	371.3813	1.452728	1.123455	0.887404	8.757125	56.77601	1.100257	18.02962	29.00288	88.36511	190.2122	0.305676

Appendix E. (Continued)

Recipe type	Recipe name	MN	VA	TH	RIB	NI	VB6	FOL	B12	PAN	BIOT	VITC	VD	VE
Traditional	TradAfricbeer	0.25221	0	0.806974	0.178442	5.263551	0.050442	14.05652	0	0.430663	3.180086	0	0	0.513386
Traditional	Amahewu	0.082873	0.604127	0.100599	0.01653	0.56619	0.019002	6.020238	0	0.133785	0.767476	0.094762	0	0.230494
Traditional	Biltong	0.017974	2.081144	0.020801	0.006626	0.176085	0.010231	7.604677	1.99E-05	0.09425	0.006386	0.623557	1.49E-06	0.048481
Traditional	Isijabane	0.332433	281.1637	0.100201	0.084275	1.582593	0.078041	24.75085	0.008394	0.297906	0.490938	4.732464	0.010556	0.693537
Traditional	Isijingi	0.249826	388.124	0.144118	0.034266	0.858254	0.140634	30.91343	0.008065	0.484173	0.830675	14.76565	0.000605	0.214846
Traditional	Isiphuphutho	0.968793	0.843818	0.166917	0.058015	5.513295	0.160926	100.3337	0	0.668972	0.328383	0.582242	7.58E-05	2.596802
Traditional	Mealie bread	0.154292	18.71123	0.151152	0.05321	1.134259	0.048583	34.44321	0	0.562491	0.296432	4.60716	0	0.31181
Traditional	Pumpkin leaves	0.505497	214.4845	0.09989	0.064996	2.60768	0.113214	35.06398	0	0.346729	0.239611	3.64352	0	1.466561
Traditional	Umbhaqanga	0.616172	8.696673	0.133598	0.043012	2.551638	0.122167	79.31554	0	0.402912	0.405746	5.208286	0.024461	1.155216
Traditional	Wild leavy vegetables	0.29376	215.2113	0.040758	0.094982	0.743676	0.024498	11.5155	2.7E-05	0.109596	0.421563	2.838829	0.00704	0.463615
Modern	TradAfricbeer	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Amahewu	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Biltong	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Isijabane	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Isijingi	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Isiphuphutho	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Mealie bread	1.045	318.2	1.0259	0.376	7.750833	0.155942	72.41667	0	0.778	0.0775	1.575	0	8.898453
Modern	Pumpkin leaves	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Umbhaqanga	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern	Wild leavy vegetables	0	0	0	0	0	0	0	0	0	0	0	0	0
Modified	TradAfricbeer	3.566667	0	0.883333	0.25	7	0.364167	56.66667	0	1.475	10.91667	0	0	1.675
Modified	Amahewu	0.315158	1.278333	0.128597	0.102806	0.905944	0.170216	36.56667	0	0.478203	0.570583	3.94	0	0.386622
Modified	Biltong	0.0016	0.015	0.000667	0.0002	0.001667	0.000333	0.693333	0	0	0	0.001333	0	0.000933
Modified	Isijabane	0.445904	501.6469	0.135297	0.095879	1.421348	0.111457	38.99724	0.00023	0.474722	0.950596	11.24037	0.039411	0.893679
Modified	Isijingi	0.7014	594.2808	0.288508	0.065658	2.090833	0.17634	68.94667	0.000333	0.842633	2.036083	16.67583	0.004192	0.2753
Modified	Isiphuphutho	0.633927	90.38045	0.185367	0.058779	2.127955	0.183372	116.6638	0	0.603344	0.303864	7.045	0.035038	2.043603
Modified	Mealie bread	0.408811	115.3116	0.289516	0.105709	2.48048	0.09529	63.12819	0.051073	1.112731	0.795187	6.568699	0.523249	2.178172
Modified	Pumpkin leaves	0.175402	151.3009	0.054649	0.033159	0.664565	0.080932	19.7059	0	0.200726	0.410539	7.356181	0.01331	0.673905
Modified	Umbhaqanga	1.361992	153.4163	0.269788	0.086842	6.585833	0.248945	165.2446	0	0.86415	0.750458	0.973333	0.78125	4.743571
Modified	Wild leavy vegetables	0.381987	116.2734	0.011701	0.034122	0.259975	0.024583	10.66534	0.012986	0.040973	0.69486	1.756322	0.007655	4.80097

Appendix F Analysis of variance tables

Information summary:
Aliased model terms
Replication stratum

Variate: ENERGY

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	5336183	2668092
Recipe_name	9	13114181	1457131
Recipe_type.Recipe _name	18	11177621	620979
Total	29	29627986	

Variate: CHO

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	2984.06	1492.03
Recipe_name	9	12123.67	1347.07
Recipe_type.Recipe _name	18	11277.54	626.53
Total	29	26385	

Variate: PROTEIN

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	311.794	155.897
Recipe_name	9	561.379	62.375
Recipe_type.Recipe _name	18	611.426	33.968
Total	29	1484.598	

Appendix F (Continued)

Variate: FAT

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	514.671	257.336
Recipe_name	9	604.493	67.166
Recipe_type.Recipe_name	18	885.038	49.169
Total	29	2004.202	

Variate: FIBRE

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	71.589	35.794
Recipe_name	9	237.33	26.37
Recipe_type.Recipe_name	18	346.361	19.242
Total	29	655.28	

Variate: Vitamin A

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	99590	49795
Recipe_name	9	351512	39057
Recipe_type.Recipe_name	18	323436	17969
Total	29	774538	

Variate: Vitamin B12

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	2.25E-04	1.13E-04
Recipe_name	9	7.55E-04	8.39E-05
Recipe_type.Recipe_name	18	1.71E-03	9.52E-05
Total	29	2.6934E-	

Appendix F (Continued)

Variate: Vitamin D

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	0.127555	0.063778
Recipe_name	9	0.239256	0.026584
Recipe_type.Recipe_name	18	0.451345	0.025075
Total	29	0.818156	

Variate: BIOTIN

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	15.2661	7.633
Recipe_name	9	51.8939	5.766
Recipe_type.Recipe_name	18	51.5969	2.8665
Total	29	118.7569	

Variate: FOLATE

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	12768.8	6384.4
Recipe_name	9	20486.3	2276.3
Recipe_type.Recipe_name	18	16066.3	892.6
Total	29	49321.4	

Variate: NIACIN

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	14.3726	7.1863
Recipe_name	9	59.8993	6.6555
Recipe_type.Recipe_name	18	82.2942	4.5719
Total	29	156.5662	

Appendix F (Continued)

Variate: PANTOIC ACID

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	1.4128	0.7064
Recipe_name	9	1.70572	0.18952
Recipe_type.Recipe_name	18	1.20459	0.06692
Total	29	4.32312	

Variate: RIBOFLAVIN

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	0.0105086	0.0052543
Recipe_name	9	0.0811275	0.0090142
Recipe_type.Recipe_name	18	0.1091916	0.0060662
Total	29	0.2008277	

Variate: THIAMINE

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	0.075704	0.037852
Recipe_name	9	1.026186	0.114021
Recipe_type.Recipe_name	18	0.969634	0.053869
Total	29	2.071524	

Variate: Vitamin B6

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	0.0845567	0.0422783
Recipe_name	9	0.0547798	0.0060866
Recipe_type.Recipe_name	18	0.0986979	0.0054832
Total	29	0.2380343	

Appendix F (Continued)

Variate: VITAMIN C

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	150.554	75.277
Recipe_name	9	257.849	28.65
Recipe_type.Recipe_name	18	179.832	9.991
Total	29	588.235	

Variate: Vitamin E

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	5.932	2.966
Recipe_name	9	36.282	4.0313
Recipe_type.Recipe_name	18	67.9745	3.7764
Total	29	110.1885	

Variate: CALCIUM

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	18206.3	9103.1
Recipe_name	9	18584.6	2065
Recipe_type.Recipe_name	18	33964.9	1886.9
Total	29	70755.8	

Variate: MAGNESIUM

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication.*Units* stratum					
Recipe_type	2	14504.2	7252.1		
Recipe_name	9	45490.1	5054.5		
Recipe_type.Recipe_name	18	45849.9	2547.2		
Total	29	105844.2			

Appendix F (continued)

Variate: POTASIUM

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	499945	249972
Recipe_name	9	764779	84975
Recipe_type.Recipe_name	18	1446666	80370
Total	29	2711390	

Variate: PHOSPHORUS

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	88149	44074
Recipe_name	9	329940	36660
Recipe_type.Recipe_name	18	275294	15294
Total	29	693382	

Variate: SODIUM

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	1308172	654086
Recipe_name	9	2905880	322876
Recipe_type.Recipe_name	18	2891470	160637
Total	29	7105522	

Variate: IRON

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	15.016	7.508
Recipe_name	9	21.2922	2.3658
Recipe_type.Recipe_name	18	24.7647	1.3758
Total	29	61.0729	

Appendix F (Continued)

Variate: COPPER

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	0.265566	0.132783
Recipe_name	9	0.28447	0.031608
Recipe_type.Recipe_name	18	0.40707	0.022615
Total	29	0.957106	

Variate: ZINC

Source of variation	d.f.	s.s.	m.s.
Replication.*Units* stratum			
Recipe_type	2	9.9501	4.975
Recipe_name	9	16.5807	1.8423
Recipe_type.Recipe_name	18	18.6291	1.0349
Total	29	45.1599	

Variate: MN

Source of variation	d.f.	s.s.	m.s.	.
Replication.*Units* stratum				
Recipe_type	2	2.48644	1.24322	
Recipe_name	9	3.52905	0.39212	
Recipe_type.Recipe_name	18	7.89796	0.43878	
Total	29	13.91346		