

# **Usage and acceptance of *Moringa stenopetala* in the diet in Ethiopia**

Masteroppgave i Folkehelsevitenskap

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*Masteroppgaven er gjennomført som ledd i utdanningen ved Universitetet i Agder og er godkjent som del av denne utdanningen. Denne godkjenningen innebærer ikke at universitetet inntår for de metoder som er anvendt og de konklusjoner som er trukket.*

## SAMMENDRAG

*Moringa stenopetala* er en plante rik på antioksidanter, som muligens kan ha en forebyggende effekt på utviklingen av leverfibrose.

Mål: Å finne ut hvordan *Moringa stenopetala* brukes i kostholdet i et område i Sør-Etiopia, hvor prevalensen av leverfibrose er funnet lav og undersøke mulighetene denne planten kan ha for å bli akseptert og inkludert i kostholdet i et annet område nord i Etiopia hvor leverfibrose er funnet høy.

Design/Metode/Utvalg: I Sør-Etiopia ble et utvalg av 21 tilfeldige kvinner fra Sille landsby som lager mat til sine respektive husholdninger bedt om å beskrive hvordan de tilberedte matretter som inneholder moringa. Basert på disse resultatene ble tre moringa retter testet ut på et utvalg av 85 individer fra 20 husholdninger i Nord-Etiopia i 2 forskjellige landsbyer (Workemado og Cheretee). Resultatene ble analysert ved multippel lineær regresjon for å sammenligne forskjeller i aksept av matrettene.

Resultater: Alle 21 kvinnene fra landsbyen i Sille laget tre like typer moringa retter som inneholdt i gjennomsnitt 10, 11 og 12 prosent moringa. Medlemmene av de 20 husholdningene i Nord-Etiopia rangerte matrettene svært positivt (gjennomsnittlig nærmere 9 av 10 mulige poeng). Det var ingen signifikant forskjell i hvor godt respondentene likte rettene vedrørende kjønn, religion, studiested, familie størrelse og alder.

Konklusjon: Denne studien viser at *Moringa stenopetala* er en plante som er lett tilgjengelig hvor bladene ofte brukes i matlaging i Sør-Etiopia. Respondentene i Nord-Etiopia likte rettene og ønsket å innføre denne typen mat i sitt kosthold hvis de hadde hatt tilgang til moringa.

Key words: *Moringa stenopetala*, Ethiopia, schistosomiasis mansoni, lever fibrosis

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## FOREWORD

This thesis was written for my master degree in Public Health at the University of Agder. The thesis is a paper-based assignment that includes an extension of the background with a further discussion. The study was conducted in Ethiopia during November 2011, and is part of the larger research project “Liver Infections, Fibrosis, Antioxidants and Phytochemicals (LIFAP)” which includes several studies on liver fibrosis in resource-poor countries in Africa. The intent of the thesis is to determine how *Moringa stenopetala* plant is used in the diet in an area of Southern Ethiopia, where the prevalence of liver fibrosis is found low and examine the possibilities this plant may have of becoming accepted and adopted in the diet in another area of Northern Ethiopia, where liver fibrosis is found high.

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## Table of contents

<b>1.0 INTRODUCTION</b> .....	<b>1</b>
1.1 <i>MORINGA STENOPETALA</i> .....	2
1.2 SCHISTOSOMIASIS MANSONI.....	4
1.3 ANTIOXIDANTS AND ITS EFFECTS .....	5
1.4 DESIGN OF LIFAP RESEARCH PROJECT IN ETHIOPIA .....	7
1.5 FOOD TRADITIONS IN CENTRAL ETHIOPIAN HIGHLANDS .....	8
1.6 OBJECTIVES.....	10
<b>2.0 METHODS</b> .....	<b>10</b>
2.1 DESIGN AND IMPLEMENTATION OF SUB STUDY 1.....	10
2.2 DESIGN AND IMPLEMENTATION OF SUB STUDY 2.....	12
2.3 QUESTIONNAIRES .....	13
2.4 STATISTICAL ANALYSIS .....	14
<b>3.0 RESULTS</b> .....	<b>14</b>
3.1 RESULTS SUB STUDY 1.....	14
3.2 RESULTS SUB STUDY 2.....	17
<b>4.0 FURTHER DISCUSSION</b> .....	<b>18</b>
4.1 DISCUSSION OF METHOD, LIMITATIONS AND STRENGTHS OF THE STUDY .....	18
4.2 DISCUSSION OF RESULTS .....	21
4.3 CONCLUDING REMARKS .....	25
<b>5.0 REFERENCES</b> .....	<b>26</b>
<b>6.0 APPENDIX</b> .....	<b>31</b>
APPENDIX 1: ARTICLE .....	32
APPENDIX 2: DIETARY QUESTIONNAIRE IN SILLE VILLAGE .....	53
APPENDIX 3: DIETARY QUESTIONNAIRE IN WORKEMADO AND CHERETEE VILLAGES .....	56

APPENDIX 4: DIETARY QUESTIONNAIRE IN WORKEMADO AND CHERETEE VILLAGES .....	58
APPENDIX 5: TABLE 1. UNADJUSTED MULTIPLE LINEAR REGRESSION.....	60

## 1.0 INTRODUCTION

The main objective of this study was to determine how *Moringa stenopetala* plant is used in the diet in an area of Southern Ethiopia, where the prevalence of liver fibrosis is found low, and examine the possibilities this plant may have of becoming accepted and adopted in the diet in another area of Northern Ethiopia where liver fibrosis is found high. As part of this master thesis an article is incorporated, which will be sent to the journal Public Health Nutrition.

This study was part of the larger research project “Liver Infections, Fibrosis, Antioxidants and Phytochemicals (LIFAP)” that works with international research on infectious and parasitic diseases in resource-poor countries in Africa, including Ethiopia. One of the project goals is to achieve information about the impact of medicinal plants, fruit and vegetables in African diet on chronic inflammation in the liver, which could help prevent the development of or promote the reversibility of schistosomal fibrosis.

The background for this study is based on previous results where Berhe et al examined the relationship between micronutrient malnutrition and schistosomiasis mansoni in two villages in Ethiopia (Berhe et al., 2007). The study included 421 school children in Sille village in South- and Workemado village in North-Ethiopia with similar prevalence and intensity of schistosomiasis mansoni infection. Results from the study showed that the prevalence of liver fibrosis in Northern Ethiopia (Workemado village) compared with Southern Ethiopia (Sille village) were significantly higher (7.0% vs. 0.6%) (Berhe et al., 2007). In addition, it appeared that school children from the Northern village had reduced antioxidant status (Berhe et al., 2007). In Sille village in South Ethiopia, a plant called *Moringa stenopetala* is an important part of the diet that is often consumed while the availability of moringa is very poor in North Ethiopia in Workemado village (Berhe et al., 2007). The study results show that both nutrition and antioxidant levels in the blood possibly can play a part on the development of liver fibrosis (Berhe et al., 2007). Berhe et al noted therefore that further in-depth nutritional studies were necessary to examine the potentials *Moringa stenopetala* as a locally, cheap alternative that can be made readily available in semi-arid areas with scarcity of vitamin-rich food (Berhe et al., 2007). A previous study has suggested the antioxidant rich *Moringa*

*stenopetala* plant to be a food item which could be associated with this disease (Abuye et al., 2003).

### **1.1 *Moringa stenopetala***

*Moringa stenopetala* (locally called “halleku”) is a green, drought-resistant plant where leaves are commonly used in cooking for human consumption (Berhe et al., 2007). The plant is a widely deciduous plant that is eaten as a vegetable in the daily diet which is distributed in the South of Ethiopia at an altitude range of about 1100-1600 meters (Mekonnen and Gessesse, 1998). Leaves from the moringa tree are a very important vegetable source which more than 5 million people depend on, especially during dry seasons (Abuye et al., 2003). The tree is resistant to both insects and pests character and is known to be a fast growing plant where one moringa tree can support a large family for many years (Abuye et al., 2003).

Currently there are thirteen known species of moringa trees in the family Moringaceae, and a study that evaluated the antioxidant effect and nutritional content of four types (*Moringa oleifera*, *Moringa peregrina*, *Moringa stenopetala* and *Moringa drouhardii*) showed that all have a high content of antioxidants (Yang et al., 2006). *Moringa stenopetala*, which is most common in Ethiopia and Kenya, has the second highest content compared with the other species (Yang et al., 2006). It is stated that all four types have an enormous potential to contribute to improved diet and health, where *Moringa stenopetala* is the most important economic species (Yang et al., 2006). Compared to other fruit and vegetables rich in antioxidants, moringa has a high content of antioxidants and is also rich in protein, calcium and iron (Yang et al., 2006).

Results from a study that compared nutrient composition in *Moringa stenopetala* leaves, kale and Swiss chard in South-western Ethiopia reported that both raw and cooked leaves of moringa contained lower amounts of protein and iron compared to kale and Swiss chard but contained a higher percentage of calcium, fiber and carbohydrate (Abuye et al., 2003). Even if the comparison of nutrient composition show that moringa leaves in most of the cases is lower compared to kale and Swiss chard, it is stated that moringa is a plant rich in vitamins and minerals that can be important in dry seasons in areas where there is lack of other vegetables (Abuye et al., 2003).

A study that fed mice with aqueous leaf extract of *Moringa stenopetala* leaves showed a significant body weight increase in mice fed with the highest extract dose (900 mg/kg body weight) compared to control group which were not fed with leaf extract (Ghebreselassie et al., 2011). The results also showed a significantly decrease in both blood cholesterol and glucose levels after treatment with moringa leaf extract compared to the control group (Ghebreselassie et al., 2011). Nibret and Wink found when testing three Ethiopian medicinal plants that using oil from moringa seeds also is effective against trypanosome parasites which causes a sleeping sickness disease of horses, sheep and cattle that is common in Africa (Nibret and Wink, 2010). Examinations of ingredients and food choices for moderately malnourished children recommended that *Moringa stenopetala* leaves could be a valuable ingredient in the diet for moderately malnourished children (Michaelsen et al., 2009).

A larger analysis of the total antioxidant content of more than 3100 different foods, showed that *Moringa stenopetala* contains high amounts of total antioxidants compared with others in the category vegetables (11.90 mmol antioxidants/100g in dried leaves/stem and 3.70 mmol/100g in fresh leaves/stem) (Carlsen et al., 2010). The conclusions drawn from the study show that the content of antioxidants in plant-based foods are much higher compared to non-plant-based foods and there are large differences between total antioxidants in various dietary plants, foods and drinks (Carlsen et al., 2010). This study is very valuable looking at potential health effects antioxidant-rich foods may have. Anwar et al reported that another moringa species (*Moringa oleifera*) has a high nutritional value with many medicinal uses which, among others, helps to reduce inflammation and is cholesterol lowering (Anwar et al., 2007).

Looking at possible side effects by using moringa, it has been suspected that the plant could be toxic, but a study where mice and rats were given seed extract from the plant showed no toxic damages in the liver after the intervention (Ferreira et al., 2009). Another study did neither find any toxic effects or death in mice treated with different doses of *Moringa stenopetala* aqueous leaf extract (Ghebreselassie et al., 2011). Mekonnen et al which looked into toxicity of extracts from plant parts of *Moringa stenopetala* suggested that moringa may be non-toxic (Mekonnen et al., 2005). A study conducted in South of Ethiopia found an association and an aggravating factor between consumption of *Moringa stenopetala* leaves and prevalence of goitre in areas with high prevalence of endemic goitre (when eaten more than two times a day for a long period of time) (Abuye et al., 1999). A study that investigated the effect of feeding moringa leaf meals to chicks showed no deleterious effects in the birds



(Melesse et al., 2011). The results indicated that chicks fed with a higher amount of moringa leaves had a higher weight gain and the protein efficiency were also higher for chicks fed with moringa leaves than birds fed with control diet (Melesse et al., 2011). There were no mortalities in chicks fed with moringa leaves but it was observed mortality in the control group (Melesse et al., 2011).

## **1.2 Schistosomiasis mansoni**

Worldwide, schistosomiasis mansoni, known as bilharzias, is the second largest parasitic disease after malaria (Chitsulo et al., 2000). It is most prevalent in Africa where resource-poor countries have poorly developed health care which makes it difficult to provide necessary help (Chitsulo et al., 2002). People get infected through water contact, for example, when washing clothes or bathing in the river. The parasites enter the skin, grow and become small worms that remain inside the blood vessels around the intestine or the urinary tract which eventually causes major problems in the liver. Liver fibrosis is the most serious end result of this parasitic infection (Manzella et al., 2008). This can lead to reduced work capacity and early death. Liver fibrosis affects only a minor part of those who gets infected.

Possible reasons for the development of liver fibrosis can be how long one live in the same place over a period of time. A study conducted in Uganda showed that people who lived in the same place for over twenty years, had twelve times increased risk of liver fibrosis (Booth et al., 2004). Another study from Madagascar showed that geographic area may also play a part where large differences in disease burden between different villages were discovered (Boiser et al., 2001).

The prevalence of schistosomiasis mansoni is high and a major public health problem where currently over 200 million people are infected and over 600 million are at risk of being infected based on World Health Organization estimates (WHO, 2002). A total of 85 % of these cases are in sub-Saharan Africa, and it is not likely that vaccines against this parasite disease will become available in near future (WHO, 2002).

A more recent study estimated 779 million people worldwide at risk of being infected and over 207 million currently infected, in addition about 20 million suffers from severe consequences (Steinmann et al., 2006). There are no new data on the total prevalence of

people infected by schistosomiasis mansoni in Ethiopia, but earlier surveys estimated it to be about 2.5 - 3 million and 18 million are at risk of infection (Ayele, 1986). These estimates are of earlier date and the population of Ethiopia has increased considerably since then, so it is possible that the current number of people infected by schistosomiasis mansoni in Ethiopia can be substantially higher today.

The impact of chronic schistosomiasis is morbidity such as anemia, fatigue, chronic pain, diarrhea, exercise intolerance, under nutrition and impaired school or work performance (King et al., 2005; King and Dangerfield-Cha, 2008). Schistosomiasis has been considered causing between 1.7 and 4.5 million disability adjusted life years in loss each year (Jordan, 2000). In particular, population-based studies have not provided a clear estimate of the effect of chronic schistosomiasis on performance status or overall quality of life.

### **1.3 Antioxidants and its effects**

Free radicals are formed in the body during normal oxidative metabolism with other oxygen- and nitrogen compounds which are all involved in damaging the body (Blomhoff, 2004). Many diseases, smoking and environmental toxins also promote the formation of these substances (Blomhoff, 2004). Antioxidants are therefore necessary and important because of its protective effect against free oxygen radicals and the body's tissues and cells (Blomhoff, 2004). Antioxidants have the ability to neutralize or eliminate these free radicals and it is important that there always is a balance between the antioxidant defense and free radicals, if not, oxidative damage accumulates and the condition oxidative stress occurs (Blomhoff, 2004). Compounds in the diet can help to strengthen the antioxidant defense, either by contributing with substances that neutralize reactive molecules directly (e.g. vitamin C, vitamin E and beta carotene) or by molecules that stimulate or enhance the cell's antioxidant defense (Blomhoff, 2004). Generally one has previously been interested in the common antioxidants, vitamin C and vitamin E, but it is now clear that there are several hundred other antioxidants in plant foods and the total content of antioxidants is therefore an important characteristic of the plants (Blomhoff, 2004). A hypothesis is that a diet consisting of high amounts of antioxidants can reduce the risk and be protective against various diseases (Carlsen et al., 2010). Foods known for its high content of antioxidants are in general, many herbs and spices, nuts, berries, whole grains, coffee, chocolate, green tea, and certain fruits

and vegetables, while other food such as dairy and meat products, contain almost no antioxidants (Carlsen et al., 2010).

To investigate which effects antioxidants may have on schistosomiasis mansoni, the antioxidant melatonin was tested on mice infected with schistosoma mansoni which showed that because of its antioxidant content, melatonin may be protective and possibly reversible against schistosomal fibrosis (El-Sokkary et al., 2002). Antioxidants such as selenium and vitamin E from dietary supplements have also in another experimental animal study shown to have a possibly effective anti-fibrotic approach (Shen et al., 2005).

Some animal studies have shown that foods rich in antioxidants may also have beneficial effects on diseases related to oxidative stress. One study reported for example that walnuts seem protective against atherosclerosis (Anderson et al., 2001). Although animal experiments have shown in some studies to possibly reduce oxidative stress, such beneficial effects have not been possible to reproduce in clinical trials and therefore there are no official recommendations for increased intake of specific antioxidant-rich foods (Blomhoff, 2004). However, it is well documented that a high intake of fruits and vegetables generally reduce the risk of many oxidative related stress diseases (Blomhoff, 2004). Until now, it is not clear which substances in these foods that have this protective effect, but compounds that enhance antioxidant defenses are good sources (Blomhoff, 2004). Thus, it is advised to increase intake of fruits and vegetables and the World Health Organization recommends an intake of 400 grams of fruits and vegetables per day (WHO, 2003). The recommendations from World Cancer Research Fund (WCRF) promotes the importance of increased intake of fruits and vegetables and recommends basing all meals on foods of plant origin for good health (WCRF, 2012). It is stated that plant foods probably are protective against a number of cancers and the aim should be to eat at least five portions of vegetables and fruits every day (WCRF, 2012). Within the recommendations on plant foods the public health goal is an average consumption of non-starchy vegetables and of fruits to be at least 600 grams daily (WCRF, 2007). Non-starchy vegetables do not include starchy vegetables like potatoes. For personal recommendation it is advised to eat at least five portions/servings (at least 400 grams) of a variety of non-starchy vegetables and of fruits every day (WCRF, 2007). Most likely, in populations where it is consumed at least 400 grams of non-starchy vegetables and fruits daily, the consumption would be at least 600 grams if one includes starchy vegetables and fruits (WCRF, 2007). However, these are all general recommendations which do not provide

recommendations for exactly which dietary plants to eat. It is therefore a remaining challenge to determine which plant foods are the most beneficial.

To improve the nutritional status of the population and especially help prevent malnutrition in Ethiopia, The Federal Ministry of Health developed a National Nutritional Strategy (NNS) in 2008 (NNS, 2008). The Government of Ethiopia has formulated this strategy where the main goal is to ensure optimum nutrition for all citizens where some vulnerable groups has more priority, like pregnant and lactating women, infants and children under five years of age and people living with HIV/AIDS (NNS, 2008). To achieve the goal of the strategy, basic nutritional intervention programs are developed, for example to improve nutrition knowledge, such as encourage preparation of food from locally available sources (NNS, 2008). This National Nutritional Strategy does not provide any specific diet guidelines or recommendations for the population of Ethiopia and it has not been found any diet recommendations for Ethiopians in the literature.

#### **1.4 Design of LIFAP research project in Ethiopia**

##### **“Liver Infections, Fibrosis, Antioxidants and Phytochemicals”**

As previously mentioned, this study is a part of a larger research project (LIFAP) aiming among others to achieve information about the impact of medicinal plants, fruit and vegetables in African diet on chronic inflammation in liver, which could help prevent the development of or promote the reversibility of schistosomal fibrosis.

The LIFAP research project has established a project plan, which includes laboratory and clinical work. For the laboratory work the project will sample and analyze antioxidant activity in food plants from different African communities, in particular Ethiopia and Yemen where collections of moringa and Khat will be studied in detail. For determination of antioxidant activity in plants, the FRAP method (the ferric-reducing ability of plasma) will be used which is a direct test of total antioxidant power that includes most of the antioxidants (Halvorsen et al., 2002; Benzie and Stain, 1999). Based on the antioxidant analysis, the ability of extracts of some of the most antioxidant-rich foods to reduce inflammation in cell culture systems will be tested. Combinations which are shown the most promising will be tested in a transgenic NFkB mouse model and acute exposure of the plant extracts (Blomhoff, 2004). To investigate the effects of the plant extract on chronic inflammation it will be established a fibrosis model

in the existing transgenic mice model. The best combinations or the best plant food candidates thereof will then be tested out in a new established fibrosis model.

Further, the results from the pre-clinical studies can be tested for compliance with human biology with a following clinical study in Ethiopia on schistosomiasis and dietary plant mix. A randomized controlled trial (RCT) on schistosomiasis anti-fibrosis will be implemented in three villages in Northern Ethiopia. Up to now 4-5000 inhabitants in the schistosoma endemic area has been screened for schistosomiasis mansoni eggs in the stool and liver fibrosis by ultrasonography, and those with schistosomal liver fibrosis will be included in the sampling frame. The intervention is planned to be a three-arm randomized, double-blinded placebo-controlled trial. One group will receive dietary plant food supplement for one year, based on the pre-clinic study results. The second group will get placebo for two months and for the rest of the year the patients will be on antioxidant-rich vegetable based dietary supplement. The third group will be only on placebo as a supplement for one year. If the interventions with antioxidant containing fruit and vegetable combination are found effective, food supplements can be advised as a public health intervention.

## **1.5 Food traditions in central Ethiopian highlands**

Ethiopia is a vast country with a topography that varies from mountains among 2000-3000 meters above sea-level to grasslands (Selinus, 1971). Compared to other countries, the different tribes in Ethiopia have their own thoughts and beliefs regarding foods (Selinus, 1971). An old research report dated back to 1971 on the traditional foods of the central Ethiopian highlands says something about what Ethiopians diet consist of, which is conducted from different parts of Ethiopia. According to this study, foods that are mostly used in the Ethiopian diet are different types of cereals like tef and maize, legumes such as chickpeas, lentils and broad beans, chicken and oilseeds used for producing oil (Selinus, 1971). The most commonly used vegetables are onions and kale, and sometimes pumpkins, green chickpeas and potatoes are used (Selinus, 1971). Among fruit, bananas and lemons are most eaten (Selinus, 1971). Spices play an important part of the Ethiopian diet, where the most important and used spice are different types of chili (Selinus, 1971).

Enjera is a leavened bread that has been used in the Ethiopian diet since 100 B.C and is an important part of the diet (Selinus, 1971). Enjera is a thin, big, pancake-like sour bread made

from different types of flour, sometimes in combination with several types like maize, tef, sorghum or barely (Selinus, 1971). This flour is mixed with water and made into a bread dough before it is baked in a special enjera pan (mitad) (Selinus, 1971). How enjera is prepared is different from place to place. It can be affected by what the main crop is, the altitude and the temperature in the area (Selinus, 1971). In parts of Ethiopia where eating enjera is the staple food, enjera is served with different sauces (Selinus, 1971). This is called wot or allicha, containing legumes, meat, chicken or fish, vegetables, tubers, onion, fat, spices and salt (Selinus, 1971). Another type of bread that is used in the diet is called Kita, which is made from whole-grain flour that can be made without being leavened (Selinus, 1971). This thick bread is baked over low heat and turned after it is baked on one side (Selinus, 1971).

Among beverage, local beer is used in the weekdays, honey wine for feasts and coffee is most used in the Highlands (Selinus, 1971). When it comes to fasting rules among the Ethiopian orthodox Christians, all food of animal origin, except from eating fish must be avoided on two days of each week and throughout lent (Selinus, 1971). The report provides no information about usage of moringa in the diet or what type of foods is eaten within Ethiopian villages.

In the literature there are few studies describing the use of moringa in the diet in the villages that participated in the study and thus it is difficult to say something about the characteristics of these areas in terms of diet and the population in general, except the use of moringa. However, Berhe et al conducted a study in Sille village in Southern Ethiopia and Workemado in Northern Ethiopia saying something about the differences between these villages. Both places have comparable levels of schistosomiasis and are endemic for malaria (Berhe et al., 2007). The people living in these villages are known to be rural peasant families or low-income farmers where there are big differences in terms of food (Berhe et al., 2007). In the Northern village, access to fruits and vegetables are very poor compared to the availability in the Southern village (Berhe et al., 2007). In Sille village in the South, they also have considerable amounts of the drought-resistant plant *Moringa stenopetala* as well as other types of fruit and vegetables which are used in the diet during most part of the year (Berhe et al., 2007).

A study that was conducted in the area in Southern Ethiopia provides some information on the use of *Moringa stenopetala*. The results from this study show that fresh leaves of moringa are eaten as a vegetable that is cooked and seasoned with oil and salt where almost every

household have at least one or two moringa trees in their compound (Mekonnen and Gessesse, 1998). Both leaves, seeds and the roots get used for multiple purposes according to the practice of the local people (Mekonnen and Gessesse, 1998). Chopped moringa leaves are mixed with water and used as tea which has a treating effect on diseases like curing malaria, hypertension, stomach pain, expulsion of retrained placenta in addition to other health problems like diabetes and asthma (Mekonnen and Gessesse, 1998). The roots are especially used for malaria treatment and the seeds are used for clearing muddy water, women also sell fresh leaves in markets (Mekonnen and Gessesse, 1998). In this study, moringa have also been tested for antifertility showing that in mice, fertility was reduced by 73.3% when extract doses of moringa leaves were consumed (Mekonnen and Gessesse, 1998).

## **1.6 Objectives**

The objectives of this study are:

1. To determine how the *Moringa stenopetala* plant is used in the diet in an area of Southern Ethiopia, where the prevalence of liver fibrosis is found low.
2. To examine the possibilities this plant may have of becoming accepted and adopted in the diet in another area of Northern Ethiopia, where liver fibrosis is found high.

## **2.0 METHODS**

The present study was conducted in two different parts of Ethiopia involving two sub-studies, Sille village in Southern Ethiopia and Workemado and Cheretee villages in Northern Ethiopia. A total of 106 study subjects that was part of the larger LIFAP study participated.

### **2.1 Design and implementation of sub study 1**

For this study assessment of how the *Moringa stenopetala* plant is used in the diet in areas where liver fibrosis prevalence is found low in Southern Ethiopia, a questionnaire was developed. In Sille village in South of Ethiopia, 21 households were randomly selected for the survey and the women who prepared food for each of the households were interviewed about

the usage of moringa in the daily cooking. They were asked what kind of moringa dishes they used to make with a detailed description of the ingredients used in the dishes and how they prepared each dish. All ingredients that were reported were calculated to find the percentage of moringa in each dish. To calculate ingredients that were listed in number/pieces, tables for volume and weight were used (Blaker and Aarsland, 1995). The questionnaire also included some questions about the general use of moringa. For further details see attached questionnaire (appendix 2).

In order to get the exact amounts of each ingredient used in the different moringa dishes, the ingredients that were difficult to find exact amount of were weighed. The study subjects did not have measuring cups so some ingredients that were reported got measured by putting the ingredient in a plastic bag to weigh it. This was done, for example, for the moringa leaves and maize flour (see picture1).



Photo by Nina Glærum

**Picture 1. Use of weight to find exact amount of ingredients used in the moringa dishes**



The respondents reported using, for example, a cup of oil as an ingredient in some of the dishes and to find exact amounts for this a syringe was used by measuring the content of the cup (see picture 2 and 3).



Photo by Nina Glærum

**Picture 2 and 3. Measurement to find exact amount of ingredients in the moringa dishes using a syringe**

## **2.2 Design and implementation of sub study 2**

For the second study, the recipes assessed in Sille village in South Ethiopia were presented for the local population in high prevalence areas in North Ethiopia in Workemado and Cheretee villages. To determine the possibilities for people in these villages to accept and adopt a diet that includes moringa, two questionnaires were developed. For the first questionnaire, 20 random opinion leading women who prepared food for the family were asked to answer a questionnaire related to cooking. The women were first showed how three moringa dishes that were assessed in Sille village were prepared. After tasting the food they answered questions related to the possibilities of making this type of food for the household. For further details see attached questionnaire (appendix 3). The women were also asked questions from another questionnaire about their opinion on the taste of the dishes, such as how well they liked each of the dishes. For more details see attached questionnaire (appendix 4). A total of 65 subjects who were in family with the women also tasted the moringa dishes and answered the questionnaire related to their opinions on the taste of the dishes.

Because of language difficulties, all study subjects were interviewed in the local language by trained project workers who later translated the answers into English. For further details on the study subjects, materials and methods, see paper.

### **2.3 Questionnaires**

To develop the questionnaires used in this study it was first checked whether already validated questionnaires that could be used for this purpose was available. Since there are few studies about the usage of moringa in the diet in the literature, the questionnaires had to be developed for assessment on the use of moringa in Southern Ethiopia and examine the possibility for people in Northern Ethiopia to accept and adopt moringa in their diet. During the process of developing the questionnaires, procedures and methodology from studies relevant to the topic was used as input. A study in Nigeria aimed to determine knowledge, attitudes and use of fermentation of food in the household using an information questionnaire (Nnanyelugo et al., 2003). Another study aimed to evaluate the sensory quality of porridges based on human senses by ranking points on a scale (Kayitesi et al., 2010).

Before this study was initiated, a test-retest was conducted for the first questionnaire, developed to assess the use of moringa in Southern Ethiopia. The results showed a correlation as high as 0.997 from test to retest. However, this pilot study were carried out on a small sample size (n=10) and in Norwegian conditions. Since moringa is a non-existing vegetable in Norway, it had to be replaced with another vegetable which was carrot since it is relatively common to use in cooking in the Norwegian diet. If this pilot study had been conducted on a group of Ethiopians instead, moringa could be used and if the sample size had been considerably larger, the results might have been different.

All three questionnaires used in this study were two-way translated to ensure the best possible validity. The questionnaires were first written in English before being translated into local language (Amharic) and then back to English to check compliance to see if the questionnaires measured what it should measure and that the translated questions gave the same meaning as the original.

Before the study was conducted in the villages, all three questionnaires were thoroughly reviewed with the project workers who would conduct the interviews to ensure that the questions were understandable. The project workers were also trained in how the interviews were going to be carried out and the importance of being thorough with each question to get the answers as detailed as possible, especially in relation to the first questionnaire in which questions were raised about how moringa dishes were prepared finding exact amount of ingredients.

## **2.4 Statistical analysis**

The statistical operations were conducted using SPSS version 18 (SPSS, Chicago, IL USA), and all analysis were performed using data from all study subjects in Northern Ethiopia (n=85). Data were analyzed by adjusted multiple linear regression method to compare if there were differences in the acceptance of the dishes, rated on a scale from 0-10. It was adjusted for sex, individuals preparing food for the household or not, religion, study site, family size, age and if the respondents had tasted moringa before or not (Table 2, paper). Data was also analyzed by unadjusted multiple linear regression method (appendix 5). The average rating on a scale from 0-10 was calculated for each dish in relation to different items. The items were appearance, smell, consistency, flavor, composition and aftertaste (Table 1, paper). A P value < 0.05 was considered significant for all statistical tests conducted.

## **3.0 RESULTS**

### **3.1 Results sub study 1**

Results from the first questionnaire conducted in Sille village in Southern Ethiopia, aiming to determine how the moringa plant is used in the diet, showed that all households prepared the same type of moringa dishes. These three dishes were “Kurkufa”, “Fosesae” and ”Kita Be Aleko”, which contained an average of 10, 11 and 12 percent of moringa. The women used more or less the same type of ingredients which were water, moringa leaves, maize flour, oil, chili, salt, onion, and a chili pepper mix containing a combination of ginger, garlic and chili pepper. There were some small differences among the households in the order of when and

what type of ingredient that was added but most prepared the dishes substantially duplicate, where the largest differences were in what way the maize flour was used.

In the description of the procedures for preparing "Kurkufa", branches was first picked from the moringa tree, where everyone owned at least one moringa tree in their own garden. The moringa leaves were then picked off from the branches and the leaves were added in boiling water. After some minutes of boiling some of the study subjects filtered out small amounts of the water before salt, chopped onion and chili was added. After these ingredients were stirred in, maize flour that was mixed together with either neutral water or the filtered water was shaped as small balls and put in the pot before oil was added. At the end, the chili pepper mix was either cooked together with the dish or added in the middle when the dish was served (see picture 4).



Photo by Nina Glærum

**Picture 4. Moringa dish used in Sille village in South Ethiopia, called "Kurkufa"**

In the preparation of the second dish, "Fosesae", moringa leaves were first picked off the branches from the tree and added in boiling water. After some minutes of boiling, some study subjects filtered out a small portion of the water. A little amount of either the filtered water or neutral water was then mixed with maize flour so it became like dry dough. This was stirred into the dish before it was cooked together with salt, oil, chili and chopped onion. At the end

the chili pepper mixture was stirred in and cooked for some minutes before the dish was served (see picture 5).



Photo by Nina Glærum

**Picture 5. Moringa dish used in Sille village in South Ethiopia, called “Fosesae”**

For the last dish called “Kita Be Aleko” which means “bread with moringa”, the bread was prepared first. Water and maize flour was made into a bread-dough which was folded into breads. The breads were put inside banana leaves to prevent from burning when it was baked over a fire, about five minutes on each side. While the breads were baked the same procedure with picking the moringa leaves was done as explained in the description of the two other dishes. After water was boiled, moringa leaves were added and cooked for some minutes. Some study subjects also filtered out small amounts of the water before the dish was cooked together with salt, oil, chopped onion and chili. At the end the mixture of ginger, garlic and chili pepper was added and boiled for a couple of minutes. After the bread was baked it was served on the side of the moringa dish (see picture 6). Main results of sub study 1 are presented in paper.



Photo by Nina Glærum

**Picture 6. Moringa dish used in Sille village in South Ethiopia, called “Kita Be Aleko”**

### **3.2 Results sub study 2**

Results from the two questionnaires conducted in Workemado and Cheretee villages in Northern Ethiopia aiming to examine the possibilities for acceptance and adoption of a diet which includes moringa, showed positive responses. On the questionnaire related to the possibilities of making this type of food for the household, 70% of the women had access to ingredients to prepare moringa dishes except from the moringa leaves. The results showed positive response both if the women would be able to make this type of food and if they had necessary kitchenware. If they had access to a moringa tree, everyone would consider including these dishes in their cooking. On the last questionnaire related to the taste of the dishes the results showed that only 5 % had tasted moringa before, which were just 4 of 85 individuals. On a scale from 0-10 the study subjects rated the three dishes giving an average score of 8.0 for “Kurkufa”, 8.9 for “Fosesae” and 8.5 for “Kita Be Aleko” (data not shown). The average rating on a scale from 0-10 in relation to appearance, smell, consistency, flavor, composition and aftertaste for each dish, showed that “Kurkufa” got 8.7, “Fosesae” 9.1 and “Kita Be Aleko” 9.0 (see Table 1, paper).

In the adjusted multiple regression there were no significant difference in how well the respondents liked the dishes regarding gender, religion, study site, family size and age (see

Table 2, paper). There were however some significant differences. “Kita Be Aleko” was scored higher by women who prepares food for the household than the individuals who do not prepare food for the household (P= 0.03). The women who prepares food for the family gave “Kita Be Aleko” a higher average score than the rest of the family. ”Fosesae” shows a significant difference between the 5% (4 individuals) who had tasted moringa before the study day and the 95% (81 individuals) who had not tasted moringa before (P= 0.03). Individuals who had never tasted moringa before the study day gave ”Fosesae” a higher average score than the respondents who had tasted moringa. The unadjusted regression analysis did not differ from the adjusted regression analysis, but it showed a significant difference in age for how well the respondents liked “Fosesae” (P = 0.05). As the age increases, the respondents like this dish better (see appendix 5). This result was not found in the adjusted regression analysis. Main results of sub study 2 are presented in paper.

## **4.0 FURTHER DISCUSSION**

### **4.1 Discussion of method, limitations and strengths of the study**

To conduct this study three questionnaires were used. Since these questionnaires had to be developed during a short period they have not been tested for validation or reliability. This makes it unclear whether or not the questionnaires really worked based on its purpose. However, to ensure the best possible validity all questionnaires was to-way translated before the study and thoroughly reviewed with the project workers who were the ones conducting the interviews. In addition, one of the questionnaires used in Southern Ethiopia aiming to assess the use of *Moringa stenopetala* were reliability tested on Norwegian conditions, showing a high correlation from test to retest. It must be mentioned that this pilot study was conducted on a small sample where moringa had to be replaced with another vegetable since the sample was not Ethiopians and thereby this is not an adequate test of the reliability of this questionnaire. It would therefore have been an advantage to conduct a pilot test of the questionnaires on a smaller sample of the people living in the villages in Ethiopia before the main study was launched to see if the questionnaires functioned as they should and to uncover possible incomprehensible questions. Due to lack of time this was unfortunately not a possibility. Although, it seemed like there were no problems according to the implementation

of the interviews, where the respondents did not show any signs of questions being unclear or misunderstood. However, the questionnaires used in this study were designed to be simple, short and straight to the point. This can be seen as a strength of this study since using simple and short questionnaires does not require as much of the respondents and do not take too long (Punch, 2003).

In Southern Ethiopia in Sille village where the recipes were found, it was an advantage to conduct the interviews with respondents at home. This made it easier to get exact amount of the reported ingredients since the respondents provided both ingredients and the equipment they used to determine the amount while they were interviewed, like cups and plates. Some of the respondents also showed parts of the procedures for preparation for some of the dishes which was helpful understanding the steps. This may not have been possible if the interviews had been carried out in another place. It also made it possible to measure the ingredients that were difficult to specify.

When calculating the percentage of moringa in each dish, the amount of food that was reported in the various dishes had to be converted into grams. To calculate these amounts, the calculated tables for volume and weight; “Mål og vekt” were used (Blaker and Aarsland, 1995). This may be considered as a limitation of this study since this book is intended for Norwegian foods. This should rather have been a book designed for Ethiopian foods but since the calculations were carried out in Norway, this book was used. However, some ingredients were measured when the recipes were collected in the village and were already given in grams. This was ingredients such as moringa leaves and maize flour, but some other ingredients were listed in number/pieces (e.g. three onions and two tablespoons of salt). These types of foods also exist in Norway so the book could be used for this.

Seen in retrospect, one limitation of the tasting part of the study in the North was the small differences seen in the preparation of the dishes from one day to another. This may have had an impact on the taste of the dishes which in turn may have influenced the results. It was commented by several one of the days, for example, that the maize balls in one of the dishes needed more cooking. In this case the preparation of the food should have been carried out more precisely to ensure that the dishes were made identical every day so the taste was the same for all respondents. Moreover, the way the tasting of the dishes was implemented before the study subjects were interviewed could also have been done differently. It was observed



that the respondents who had finished the interviews were talking with others and commenting the food which may have influenced people's opinions, even though the interviews were carried out individually. For this part of the study it could have been set more specific rules, such as the respondents who had tasted the dishes and been interviewed had to leave the area where the study was conducted.

Further, this study only included quite few people and the sample could advantageously been greater. Still, the study was carried out very systematically, where a random sample of those living in the villages was drawn from a list where all households were registered. This made it possible to obtain a wide range within the population providing a spread of those who participated in the study within the villages. In addition, the women in the North who were asked questions related to the possibilities of making this type of food were a random sample of 20 opinion leading women from the villages. Compared to other sites it seemed like these women had an authority in the villages, so it was important to get these women involved. Opinion leaders are often known to be someone who is speaking out which people often contact for advice. Thus, opinion leaders have an important voice in a society. These women are also the ones preparing food for their respective families so it is important that these particular women will accept this type of food, which includes moringa.

A strength of the second study conducted in the Northern villages was by using two different questionnaires to examine the acceptance and adoption of the moringa plant. In addition to interview the respondents about their opinion on the taste of the dishes, it was also developed a questionnaire related to the possibilities of making this type of food. Also, the 20 women from the two villages did not just get a list over ingredients included in the dishes and asked questions related to the possibilities of preparing this kind of food. The women were shown each and every step in the preparation before they tasted the dishes and answered the questions. By using both these questionnaires you not only find out if the people in the North will accept to eat food that contain moringa, but also examine how the possibilities actually is that this food can be prepared by those responsible for cooking in the household. This is important to find out if they should be able to use moringa in their diet. It was also an advantage to use an inhabitant from Sille village together with a trained cook to ensure that the dishes were prepared the same way as the original when shown in front of the women.

A weakness of this study is that the respondents only have tasted this type of food on one occasion in which they got only a taste of each dish. The respondents have therefore not tasted the dishes for several times over a longer period of time which can make it difficult to draw accurate conclusions on how well they like these dishes. For more discussion, see paper.

## **4.2 Discussion of results**

The results from the first study in Sille village of Southern Ethiopia showed that every subject owned their own moringa tree where the majority used fresh leaves. Everyone used the same type of moringa dishes with small differences in how the maize flour was used. The three dishes were called “Kurkufa”, “Fosesae” and ”Kita Be Aleko”. ”Kurkufa”, that is part of the staple diet in Southern Ethiopia is also known as a delicacy for the local people (Abuye et al., 2003). When testing the dishes in Northern Ethiopia, both results on the taste of the dishes and the women’s possibilities of making this type of food were positive. The moringa dishes were rated with a high average score, where the dish that got the highest score also had the highest content of moringa, based on the calculations from Southern Ethiopia. If moringa had been available, most of the study subjects wanted to consider introducing moringa in their diet. This indicates that the respondents liked the dishes and that moringa can have a possibility of being adapted to another place.

It must be said that this study is very simple, but also an important study to determine whether people in the Northern villages will accept to eat food consisting of moringa. Considering the results, this is therefore a good starting point and a positive preliminary study before starting a possible further work with an intervention of increasing intake of moringa. Based on the implementation of this study some of the inhabitants are also already a bit familiar with these dishes.

Seen in connection with the fact that as few as 4 of 85 respondents have tasted moringa before, it is fascinating to see that so many of the respondents are so positive to something most of them have never tasted. This also provides a good opportunity to conduct a successful intervention, considering that they are going to eat this kind of food.

One reason why the results were as good could be affected by the fact that the respondents who tasted the food for some reason wanted to give some extra positive feedback on the

dishes. This is known as pleasing bias, where study subjects can be differentially interested to please for example the investigator of a study (Goldfarb, 2007). However, before the study was implemented the respondents were told that it was important that they gave honest feedback and not to give answers they thought that we wanted.

The study results showed no significant difference in how well the dishes was liked, regarding sex, religion, study site, family size and age (see Table 2, paper). For one of the dishes, “Kita Be Aleko”, there were a significant difference between the women who prepares food for the household which liked the dish better than the individuals who do not prepare food ( $P= 0.03$ ). “Fosesae” was scored lower by individuals who had tasted moringa before the study day than the individuals who had not tasted moringa before ( $P= 0.03$ ). Since it was a skewed distribution in groups the results show no large differences between the groups. If this study had included a wider range and it had been more even distribution between the groups it could formed greater variations in the results. For example, there were only 4 individuals in the group who had tasted moringa before compared to 81 in the other group who had never tasted moringa before.

If a future intervention study shows that eating moringa can reduce or prevent the development of liver fibrosis which results in planting moringa trees in the North, one cannot know if the inhabitants really start using moringa leaves in cooking. This is because they have not had access to the moringa tree before and the majority does most likely not know how to use it. Thus, some important criteria must be set if this should be feasible. First of all, the moringa trees need to be easily available for those living in the villages. Compared with the results in South Ethiopia where 95% use fresh leaves, everyone have a minimum of one moringa tree in the garden. Further, to get people accept eating a completely new and different type of food does not necessarily have to be easy. In this regard, it is important to promote the use of the tree, by making the public aware of it by informing the inhabitants about why it is beneficial to include moringa in the diet. A large number of households must also be trained in how to prepare dishes that includes moringa in order to take advantage of the plant and inhabitants must be encouraged to eat the leaves along with their staple foods. Since the opinion leading women have a big influence in these communities, it is important to keep including such authoritarians in the process. Hopefully, with information like this the inhabitants will become aware of the trees beneficial uses and start including moringa in the diet.

In the context of a lack of developed health care systems in resource-poor countries in Africa (Chitsulo et al., 2002), and knowing that it is doubtful that vaccines against the parasite disease will become available in near future (WHO, 2002), it is valuable to come up with preventive medicine, such as low cost, locally available alternatives. Such alternative solutions are important in the effort to improve the public health. To prepare food from locally available sources was among others encouraged by the National Nutritional strategy aiming to improve the nutritional status of the Ethiopian population (NNS, 2008). Therefore, if moringa is proved to be such an alternative source that possibly can reduce or prevent the development of liver fibrosis, it can have a major impact on the public health for the inhabitants in these areas.

Besides the potential health effects *Moringa stenopetala* may have, it is also encouraging to see the other various benefits of this plant, especially considering an extension of how moringa can be used in Northern parts of Ethiopia. First of all, moringa is a drought-resistant plant (Berhe et al., 2007) which during dry seasons is full of leaves when other foods are typically scarce (Abuye et al., 2003). Secondly, it is a fast growing tree which is resistant to insects and pests character, and one single tree can support a whole family for many years (Abuye et al., 2003). Moringa leaves are also recommended to be a possibly valuable ingredient in the diet for moderately malnourished children (Michaelsen et al., 2009). It is especially mentioned that moringa leaves can be vital in areas where there is a scarcity of vegetables (Abuye et al., 2003). This is crucial in Northern Ethiopia, where access to fruits and vegetables are very poor (Berhe et al., 2007).

Apart from all the benefits of the tree, in addition to be a potentially cheap, locally available vitamin-rich food source (Berhe et al., 2007), it is encouraging to see that leaves of moringa also has many medical values (Mekonnen and Gessesse, 1998; Nibret and Wink, 2010). In the context of moringa being used so frequently in the diet which inhabitants in Sille village in Southern Ethiopia benefits from, it shows that moringa can have a good chance of being feasible in the Northern villages in Ethiopia as well. In addition, since a few moringa trees are found in Northern Ethiopia, this suggests that moringa can easily be grown in Northern parts of Ethiopia.

The literature about moringa show that the plant has been tested for possible side-effects. Among others, toxicity (Ferreira et al., 2009; Ghebreselassie et al., 2011; Mekonnen et al., 2005) and that moringa have been associated with development of goiter (Abuye et al., 1999). The effect of feeding moringa leaves to chicks has also been studied (Melesse et al., 2011). All studies on toxicity suggest that moringa is a non toxic plant, which is positive. It is important to note that most of these studies on possible side-effects are results provided from animal experiments which have not been investigated in humans. Perhaps the most compelling documentation to determine the safety of using moringa is the frequent use in traditional Ethiopian households which show no documented side effects.

In Northern Ethiopia, where the moringa dishes were tested out the results showed that some of the study subjects wanted to eat the dishes with enjera, cabbage or by adding more spice if they could change something with the dishes. This suggests that the inhabitants of the Northern villages use other types of foods compared with Southern Ethiopia, like include eating the moringa dishes with enjera or kale, which are known as common traditional food for Ethiopians (Selinus, 1971). It is not known with certainty whether these foods or other types of food also are used in the diet in Sille village since the aim was only to collect information about the use of moringa in the South. Also, besides that moringa leaves are used for food consumption in Sille village, it is not known if moringa is used for other purposes, for example for medical uses such as Mekonnen and Gessesse reported (Mekonnen and Gessesse, 1998).

The study in Sille village showed that except from the moringa leaves, maize flour, onion, chili and oil were commonly used ingredients in the moringa dishes, which are some of the most used foods in Ethiopia (Selinus, 1971). The procedures of how moringa is prepared in Sille village are quite similar with the documentation on the uses of *Moringa stenopetala* which showed that moringa leaves are cooked and seasoned with oil and salt (Mekonnen and Gessesse, 1998). Similar with the results in Sille village, it was observed that almost every household in the different villages in Southern Ethiopia had at least one or two moringa trees in the garden (Mekonnen and Gessesse, 1998).

The report on Ethiopian food traditions provides no information about using moringa in the diet. A reason for that may be because the use of moringa is only common in smaller parts of Ethiopia, and thus it may not be described as traditional food in Ethiopia. Moreover, it is not

certain that the study which were undertaken to report the traditional foods of Ethiopia included areas where moringa is commonly used in the diet. For more discussion of the results, see paper.

### **4.3 Concluding remarks**

*Moringa stenopetala* is a plant easily available that is commonly used in cooking in three rather similar dishes in Southern Ethiopia. In Northern Ethiopia, both feedback on the taste of the dishes and the women's possibilities of making this type of food if they had access to moringa showed positive responses. Most of the respondents wanted to introduce moringa in their diet if the leaves had been available. These results show that this type of food rich in antioxidants can have a good opportunity of being adapted to other places which possibly can reduce or prevent the development of liver fibrosis. This may improve the public health for people living in these areas where the prevalence of liver fibrosis is high.

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## **6.0 APPENDIX**

**Appendix 1:** Article. Usage and acceptance of *Moringa stenopetala* in the diet in Ethiopia

**Appendix 2:** Dietary Questionnaire in Sille village

Question to individual households preparing moringa dishes in Sille

**Appendix 3:** Dietary Questionnaire in Workemado and Cheretee villages

Question to individuals preparing food for the household

**Appendix 4:** Dietary Questionnaire in Workemado and Cheretee villages

Questions to individuals tasting the food

**Appendix 5:** Table 1. Unadjusted multiple linear regression

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**PAPER:**

**Usage and acceptance of *Moringa stenopetala* in the diet in Ethiopia**

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## Usage and acceptance of *Moringa stenopetala* in the diet in Ethiopia

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## ABSTRACT

*Moringa stenopetala* is an antioxidant-rich plant, which possibly can prevent development of liver fibrosis.

Objective: To determine how *Moringa stenopetala* is used in the diet in an area of Southern Ethiopia, where prevalence of liver fibrosis is found low, and examine the possibilities this plant may have of becoming accepted and adopted in the diet in another area of Northern Ethiopia where liver fibrosis is found high.

Design/Setting/Subjects: In South Ethiopia, 21 randomly selected women from Sille village who prepares food for their respective household were asked to describe how they prepared dishes containing moringa. Based on these results three moringa dishes were tested out on 85 subjects from 20 households in North Ethiopia (Workemado and Cheretee villages). The results were analyzed by multiple linear regression to compare differences in the acceptance of the dishes.

Results: All 21 women from Sille village prepared the same three types of moringa dishes, containing an average of 10, 11 and 12 percent of moringa. Members of the 20 households in Northern Ethiopia rated the dishes very positively (average close to 9 of 10 possible points). There were no significant difference in how well the respondents liked the dishes regarding sex, religion, study site, family size and age.

Conclusions: This study shows that *Moringa stenopetala* is a plant easily available with leaves commonly used in cooking in Southern Ethiopia. The study subjects in Northern Ethiopia liked the dishes and wanted to introduce this type of food in their diet if moringa was available.

## INTRODUCTION

Schistosomiasis mansoni is known as the second largest parasitic disease worldwide after malaria<sup>(1)</sup>. The prevalence is high and the disease is a significant public health problem since currently 200 million people are infected<sup>(2)</sup>. A total of 85 % of these cases are in Africa, where health services are inadequate, thus the risk of complications is high. Furthermore, the prevalence of disease is relatively high in Africa compared to other parts of the world because of availability of vector snail and suitable environment<sup>(3)</sup>. The most serious result of this parasitic disease is liver fibrosis<sup>(4)</sup>.

In Ethiopia, parts of the population become sick as a result of parasites transmitted through water contact, which eventually causes major problems in the liver (e.g. Schistosomiasis mansoni). Research has shown that a plant called *Moringa stenopetala* (locally called “halleku”) may have a positive effect on preventing the development of liver fibrosis<sup>(5)</sup>. Compared with other vegetables the plant has high antioxidant content<sup>(6)</sup>. Moringa is used in the diet in Southern Ethiopia, and it has been suggested that this is the reason that the prevalence of schistosomal liver fibrosis is low there compared to other parts of the country<sup>(5)</sup>. Moringa is a substantial ingredient of the basic diet for those living in the villages in parts of Northern Omo Administrative Zone of Southern Ethiopia like Sille, where households have good access to the plant as well as other types of fruits and vegetables. In the villages like Workemado and Cheretee of Kemisse Administrative Zone in the North of Ethiopia, however, the prevalence of liver fibrosis is high and they do not have the similar access to the moringa plant and other vegetables as in the South<sup>(5)</sup>. Therefore, it is speculated that this antioxidant-rich plant can have a positive preventive effect on the development of liver fibrosis.

It is therefore of interest to conduct an in-depth study on the use of moringa in the South and to assess if meals based on this plant can be accepted in the diet in Northern areas. In resource-poor areas moringa can easily be a cheap alternative vitamin source, which also might reduce the prevalence of liver fibrosis if found effective. To our knowledge there are few studies about the usage of moringa in the diet in the literature. Such studies would be beneficial in planning dietary interventions to help prevent liver fibrosis in African countries.

The aim of this study was to determine how the *Moringa stenopetala* plant is used in the diet in an area of Southern Ethiopia, where the prevalence of liver fibrosis is found low, and



examine the possibilities this plant may have of becoming accepted and adopted in the diet in another area of Northern Ethiopia where liver fibrosis is found high.

## **EXPERIMENTAL METHODS**

### **STUDY SUBJECTS, MATERIALS AND METHODS**

The present study was a component of the larger research project “Liver Infections, Fibrosis, Antioxidants and Phytochemicals (LIFAP)” which includes several studies on liver fibrosis in resource-poor countries in Africa. One of the project objectives is to achieve information about the impact of medicinal plants, fruit and vegetables in African diet on chronic inflammation in liver, which could help prevent the development of or promote the reversibility of schistosomal fibrosis.

The present study was conducted during November 2011 involving two sub-studies in two different parts of Ethiopia as a part of the larger LIFAP study.

#### - Sub study 1

The first study was conducted in Sille village, Southern Ethiopia (Northern Omo Administrative zone, situated about 520 km southwest of Addis Ababa, 1300 meters above sea level (m.a.s.l.)). The study objective was to assess the use of *Moringa stenopetala* among inhabitants of Sille village.

In the village where the survey was conducted each house had a registered house number from earlier projects with information about inhabitants of each household. Based on these lists 21 households were randomly selected for the survey and visited one by one. Females in charge of the cooking were interviewed at home in the local language by trained project workers, who filled in the responses and later translated them into English. A total of 3-4 interviews were conducted each day.

Data was collected from women who prepare food for the household (aged 17-50 years) using a questionnaire. They were asked to describe how the plant was used in the daily diet. Respondents would give the name of the dishes that contained moringa and explain the procedures of how each dish was prepared with detailed description and presentation of

ingredients, which were eventually weighed. The majority of the questionnaire was simple ticking off and more detailed description was given when necessary. The questionnaire had both closed and open-ended questions so the respondents had the opportunity to give their own answers in addition to choose between different answers already set. The questionnaire included the following questions:

1. How often do you use moringa as an ingredient in your cooking? The respondents could choose between: more than once a day, once daily, 1-3times/week, once weekly, 1-2 times a month or less than once a month.
2. At what time during the day are dishes containing moringa served? The alternatives were: for breakfast, for lunch, as a snack, for dinner, for breakfast and lunch, for lunch and dinner, for every meal or others.
3. How do you get access to the leaves from the moringa tree? Response alternatives were: I buy them, from my own moringa tree, collect from bush or others.
4. Do you usually pick the leaves on the same day that you use them for cooking? Here the respondents had to tick off for yes or no.

In addition they had to give answers regarding family size, age, sex and religion.

In order to get the exact amount of ingredients from the moringa dishes, some ingredients were measured and weighed where it was difficult to find exact amounts, for example, how much oil, moringa leaves and maize flour that was used. Some of the respondents also showed parts of the procedures for preparation for some of the dishes while they were interviewed. To learn exactly how the different dishes were prepared a cook was trained to learn how to make the food by inhabitants of the village. Results from this survey were used as a basis for transfer of the diet to Northern Ethiopia.

To calculate the percentage of moringa in each dish, the amount of food that was reported in the various dishes had to be converted into grams. Moringa and maize flour was already given in grams but respondents had listed some of the ingredients in number/pieces. This was for example, two onions, one tablespoon of salt and one chili. To calculate these amounts, tables

for volume and weight were used <sup>(7)</sup>. These tables include conversion from number or volume (dl, ml, glass, etc.) to grams for most food groups. Total amount of food in the various dishes were calculated to determine the proportion of moringa in the dishes. In pursuit of this some choices were made. If any of the respondents, for example, said one to two onions, this was valued at one and a half onion and then converted into grams.

#### - Sub study 2

The second study was carried out in Northern Ethiopia, more specifically Workemado and Cheretee villages which are two of the most disease exposed villages in North Ethiopia (Kemisse administrative zone,  $\approx$  320 km north of Addis Ababa at an altitude of 1500 m.a.s.l.).

The objective of the second study was to determine if it was possible for people in the LIFAP study area in Northern Ethiopia to accept and adopt a diet that includes *Moringa stenopetala*. Two different questionnaires were designed to answer this.

The first survey was conducted on a random sample of 20 opinion leading women from the two villages. Ten women from Workemado village (aged 16-45 years) and ten women from Cheretee village (aged 20-50 years). Each group was recruited through health workers in the villages and the sample of women was those who prepared food for the household. These were therefore asked to complete a questionnaire related to cooking.

The women were invited to a cooking place close to each village, where the three most common moringa dishes based on the surveys from the South were prepared by a cook together with a project worker from Sille village and some other project workers. Having an inhabitant from Sille village together with the project staff was done to ensure the quality of the dishes so they became as similar as possible to the original. The respondents were first showed how the dishes were prepared, one dish at a time, with a thorough review of each step of the preparation. Afterwards they tasted each dish before they were asked questions about the possibilities of making this type of food for the household. The study subjects were interviewed one at a time in the local language by trained project workers. Later the answers were translated into English. The survey included the following questions:

1. Do you have access to ingredients for making these dishes?

2. Do you have kitchenware to make these dishes?
3. Would you be able to make some of these dishes?
4. If you had access to a moringa tree, would you consider including dishes containing this plant in your cooking?
5. If you were supposed to use moringa in your daily cooking, how would you prepare a dish containing moringa as an ingredient?

Questions 1-4 were formulated so the respondents could answer either yes or no. If they answered no to a question they were asked to explain why. The last question was open-ended allowing the respondents to give their own answers.

In addition, the sample of women also answered another questionnaire related to their opinions about the taste of the dishes. This survey included the questions:

1. Have you eaten moringa before? Tick off yes or no.
2. How well did you like each of the dishes? The respondents were asked to assign a number for each of the three dishes on a scale from 0-10 where 0 were the lowest score and 10 were the highest. The average rating for each dish was calculated.
3. How well did you like each dish in relation to each of the items below? The respondents had to assign a number from 0-10 for each dish in relation to: its appearance, its smell, its consistency, its flavor, its composition and its aftertaste. For each number that was given by all respondents, the average score of each item and the average overall score was calculated for each dish.
4. Would you consider introducing some of these dishes in your diet if moringa was available? Tick off yes or no.
5. What would you change if you were to eat some of these dishes? The alternatives to choose between were: the appearance, the smell, the consistency, the flavor, the composition or the

aftertaste. The respondents could choose to tick off for several of the alternatives in addition to give other reasons.

The final questionnaire related to the tasting was also implemented on the families of the women presented above (in total 65 people), both children and adults. The women in the initial study approved that their own family could participate and the women themselves recruited the subjects. These were 35 women (aged 9-76 years) and 30 men (aged 7-58 years). The three dishes were prepared in the two villages and the respondents came to taste the food, followed by answering the questionnaire related to their opinions about the taste of the dishes. For both questionnaires all study subjects had to state family size, age, sex and religion.

In order to get access to the leaves in Northern Ethiopia the project workers picked fresh leaves from the few trees that existed a few kilometers from the villages to be able to make the dishes.

All three questionnaires used in the studies were designed to be short and contain simple and not too detailed questions where the main focus was on the objectives of the study. All questionnaires were translated two-way before the studies were initiated to ensure that the meaning was the same after translation. The questionnaires were first written in English before being translated into the local language (Amharic) and then translated back into English.

## STATISTICAL ANALYSIS

The records of the collected data were entered in Excel and every entering was double checked as a quality assurance before the statistical analysis was done using SPSS, version 18 (SPSS, Chicago, IL USA). Data were analyzed by adjusted multiple linear regression method based on a 5% level of significance to compare if there were differences in the acceptance of the dishes, rated on a scale from 0-10. It was adjusted for sex, individuals preparing food for the household or not, religion, study site, family size, age and if the respondents had tasted moringa before or not. Data was also analyzed by unadjusted multiple linear regression method. The average rating on a scale from 0-10 was calculated for each dish in relation to different items. These were appearance, smell, consistency, flavor, composition and aftertaste. All analysis were performed using data from all study subjects in Northern Ethiopia (n=85).

## ETHICAL CONSIDERATIONS

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Regional Committee for Medical Research in Norway (REK-Øst) and from the Ethiopian National Ethical Clearance Committee of Ethiopia for Ethiopian studies. Verbal informed consent was obtained from all subjects or the guardians before the study was conducted. Verbal consent was witnessed and formally recorded. Each subject was made aware that this was a voluntary survey and they could withdraw at any time.

## RESULTS

### - Sub study 1

The results from the first study in Sille village showed that all 21 women (48% orthodox Christians and 52% protestant Christians) who prepared food for the family made the same type of moringa dishes. These three dishes were called “Kurkufa”, “Fosesae” and “Kita Be Aleko” (in local language/Amharic). The women used only the leaves from the moringa tree and there was little variation regarding type of ingredients and how they were used in each dish. The ingredients consisted of maize flour, water, moringa leaves, oil, chili, salt, onion, and a chili pepper mix which contained a combination of ginger, garlic and chili pepper. The chili pepper mixture was equivalent to approximately one tablespoon after it was mashed together using two stones. One of the subjects used red beans in addition as an ingredient in the “Fosesae” dish.

The procedures of making the three dishes were quite similar. The largest difference was how the maize flour was used. In the first dish “Kurkufa” the maize flour was mixed together with water and shaped as small balls before they were cooked with the rest of the ingredients. In the second dish, “Fosesae” the maize flour was mixed with a small amount of water so it became like dry dough and then stirred into the dish before it was cooked together with the other ingredients. For the last dish called “Kita Be Aleko” that means “bread with moringa”, the maize flour and water was made into a bread-dough and folded into breads that was baked over a fire. The breads were kept inside banana leaf to prevent from burning and after being baked the breads were served on the side of the moringa dish.

For all of the dishes the water was boiled before the moringa leaves were put into the pot and cooked for a couple of minutes and then the rest of the ingredients were added (salt, maize flour, chili, onion, oil and the chili pepper mix). Many of the subjects also filtered out small amounts of the water after the moringa leaves were boiled and used this water to dissolve the maize flour.

For all households the dishes were prepared in almost exactly the same way, but with relative differences in amounts of ingredients because of the variations in family size. Moreover, there were some differences among the households in the order of when and what type of ingredient that was added. Some added for example the chili pepper mixture in the middle of the dish when it was served and some mixed it together with the rest of the ingredients while it was cooked.

Average percentage of moringa was compared in each dish. "Kurkufa" contained 10%, "Fosesae" 12% and "Kita Be Aleko" 11%. The women were asked how often they used moringa as an ingredient in their cooking and 19 % used it more than once a day, 76% used it once daily and 5% said 1-3 times/week.

On the question regarding at what time during the day the dishes were served 80% of the women said that if it was prepared for breakfast it was also used for lunch and if it was prepared for lunch it was also used for dinner. The rest served it for breakfast (5%), for dinner (5%), for breakfast and lunch (5%) and 5% for every meal. All of the households owned their own moringa tree in the garden and 95% of the women picked the leaves on the same day that they used them for cooking. All study subjects made the dishes for all of the family members without one who made it to a person less since one in the family was an infant.

#### - Sub study 2

The 20 women who prepared food for the household from the two villages in the North were all Muslims. A total of 70 % answered that they had access to ingredients to prepare moringa dishes except for the moringa leaves. All of the women had kitchenware for making the dishes and if they had access to a moringa tree, everyone would consider including dishes containing moringa in their cooking. The women were asked if they would be able to make

some of the dishes and 95% of them said yes. On the question where the women were asked to describe how they would prepare a dish that included moringa, 60% wanted to prepare it the same way as they observed by the cook. Some wanted to add different and additional ingredients to give the dishes more flavor (15%) and some wanted to eat the dishes with "enjera" (25%). "Enjera" is a local thin, spongy leavened, pancake-like sour bread made of either barley, tef-, sorghum-, rice- or maize-flour, sometimes a mixture of two or three of these. This is combined with "Shiro-wot" made from beans or lentils with onions, cooking oil and chili pepper. The rest answered that they wanted to eat the moringa dishes with cabbage (5%). It was also pointed out by 10 % that the maize balls in the "Kurkufa-dish" should be cooked for a longer time and also be of a smaller size. There were no significant differences in the answers between the women from the two villages.

The results from the second questionnaire in the North related to the tasting of the dishes (n=85), where of 95% were Muslims and 5% orthodox Christians, only 5% had tasted moringa before. Average rating on a scale from 0-10 for each dish was compared where 0 was the lowest and 10 the highest score. "Kurkufa" were rated to 8.0 (SD 2.3), "Fosesae" 8.9 (SD 1.7) and "Kita Be Aleko" 8.5 (SD 2.1).

Results on the average rating for each dish in relation to different items are given in Table 1. The respondents were asked to assign a number on a scale of 0-10 in relation to appearance, smell, consistency, flavor, composition and aftertaste for each of the dishes (0 were the lowest and 10 were the highest score). In total the results show a high average rating for all three dishes. "Fosesae" with 9.1 closely followed by "Kita Be Aleko" (9.0) and "Kurkufa" (8.7). The respondents were asked if they would consider introducing some of the three dishes in their diet if moringa was available and for each dish they had to tick off either yes or no. An average of 67% wanted to consider introducing "Kurkufa", 80% "Fosesae" and 81% "Kita Be Aleko".

The average score of the three dishes were tested to see if there were any differences in rating for different variables like sex, respondents preparing food for the household or not, religion, study site, family size, age and if the respondents had tasted moringa before or not (Table 2). The results in Table 2 show that there are no statistically significant difference in how well the respondents liked the three dishes that was rated on a scale from 0-10 regarding sex, religion, study site, family size and age. "Kita Be Aleko" was scored higher by women who



prepares food for the household than the individuals who is not preparing food (P= 0.03). “Fosesae” was scored lower by individuals who had tasted moringa before the study day than the individuals who had not tasted moringa before (P= 0.03). The unadjusted regression analysis showed the same results, as well as a significant difference in age for how well the respondents liked “Fosesae” (P = 0.05). We could not find this result in the adjusted regression analysis.

## DISCUSSION

In the Sille area of South Ethiopia every subject used the same type of moringa dishes with small differences in how the maize flour was used. Everyone owned their own tree in the garden, from which fresh leaves was used by most respondents. Moringa leaves are often used once daily by many respondents if a dish has been prepared. In the Kemisse area of Northern Ethiopia, both feedback on the taste of the dishes and the women’s possibilities of making this type of food if they had access to moringa showed positive responses. Few respondents had tasted moringa before but never the less they provided high positive ratings on the dishes.

The results in Sille village show that all of the women used only the leaves from the moringa tree to prepare food for the household. Besides knowing that *Moringa stenopetala* is a plant high in nutritional value and rich in antioxidants<sup>(6,8,9)</sup> with the second highest content compared to other species, the leaves also contain higher values of antioxidants than the stem<sup>(9)</sup>. Since the women reported that they always boil the fresh leaves, the availability of iron (in vitro iron bioavailability) also increases by 3.5 times whereas raw leaves give a lower effect<sup>(9)</sup>. In addition, when moringa leaves are boiled the antioxidant activity in the water also improves<sup>(9)</sup>. Since many of the women reported using the water that was filtered out from the dishes to mix with the maize flour, this will lead to increased antioxidant content in the dishes.

The average percentage of moringa of the three dishes the women prepared for their family in Sille village were calculated. The results show that “Fosesae” got the highest content of 12% compared to the other dishes (“Kita Be Aleko” 11% and “Kurkufa” 10%). “Kurkufa”, that is part of the staple diet in Southern Ethiopia is also known as a delicacy for the local people<sup>(8)</sup>. Comparing this result with the average rating for each dish in Workemado and Cheretee villages in Northern Ethiopia, the results is showing a correlation. “Fosesae” got the highest

average score of 8.9, second “Kita Be Aleko” rated to 8.5 and last “Kurkufa” with 8.0. This shows that “Fosesae”, who had the highest percentage of moringa were rated the highest.

In relation to appearance, smell, consistency, flavor, composition and aftertaste, "Fosesae" is also rated by the highest overall score compared to the other dishes. But it is important to emphasize that there are no significant differences in the total score between the different dishes, which indicates a general positive acceptance of the dishes.

In order to get as correct answers as possible from the respondents, they were informed about the importance of answering as sincerely and honest as possible, based on their own opinions of the dishes and not to give us the answers they thought we wanted. They were told that this study was conducted to help them improve their health and give a beneficial nutritional effect.

The overall rating indicates that respondents liked all of the dishes with an average high rating. As high as 81, 80 and 67 percent wanted to consider introduce “Kita Be Aleko”, “Fosesae” and “Kurkufa”, respectively, if the plant was available.

Since the women are the ones making the dishes for the rest of the family, it is encouraging to see that all of them wanted to consider cooking the dishes if they had access to the leaves. A total of 70 % reported having the additional ingredients to create the dishes and all of them had necessary kitchenware. The results show no indication that the women have difficulties making the dishes apart from the lack of the moringa leaves. When the women were asked how they would prepare a dish containing moringa it turned out that most of them wanted to prepare it the same way as the cook showed them, although some of them would add other ingredients. This opens up the possibilities that the women would make the dishes in their own way, based on what they like, such as eating the dish with "enjera". As long as the dish still contains enough amounts of moringa leaves and important spices to provide a positive nutritionally impact, this is positive.

Regardless of gender, religion, study site, family size or age it shows that the respondents liked the dishes. The results show no significant differences between villages and can therefore be treated as a group, which was not surprising since the sample size was quite low. A few differences were discovered between the women preparing food for the household who rated “Kita Be Aleko” with a higher average score than the individuals who does not prepare

food and the individuals who had never tasted moringa before the study day rated “Fosesae” with a higher average score than the individuals who had tasted moringa before.

A limitation of this study in relation to the implementation was how the tasting part was carried out. The dishes were made in the morning and served throughout the day as the respondents came to taste. This may have had an impact on the taste since the dishes eventually was served cold and kept for some time for those who came later in the day. The smell and taste of freshly cooked food and newly baked bread may have played a role. When respondents tasted the dishes, several subjects came at the same time and sat next to each other when the dishes were served. This could have influenced their opinion on the food in relation to discussing the dishes with the person sitting next to them, even though the interview was carried out individually. Some of the respondents even stayed after they were finished where the study was carried out and may have affected the new subjects in their responses by commenting the dishes when they tasted the food.

Another limitation of the study was in relation to how the dishes were prepared. When the respondents were asked what they wanted to change if they were to eat some of the dishes the answers showed some differences from one day to another. It might seem like there may have been small differences in the preparation of the food. This is in terms of small variations in the composition such as spices and cooking time. It was commented the second day by several respondents, for example, that the maize balls in one of the dishes (“Kurkufa”) should have been cooked for a longer time because they were not well done because the sizes were too big.

Since the questionnaires that were used in this study had to be developed they have not been validated, which was a limitation of this study. However, before the study were conducted, all three questionnaires were two-way translated to ensure the best possible validity. Moreover, the sample of this study could advantageously been greater.

Besides that moringa can be a potentially cheap, locally available vitamin-rich food source in areas with scarcity of vegetables <sup>(5)</sup>, it is positive to see the other various benefits of this plant. Moringa is a drought-resistant, fast growing plant, which is resistant to insects and pests character and one single tree can support a whole family for many years <sup>(8)</sup>. In addition, results on toxicity studies of moringa are encouraging <sup>(10, 11, 12)</sup>. As well as being eaten,

*Moringa stenopetala* has a variety of uses such as treating malaria and other internal health problems <sup>(13)</sup>.

## **CONCLUSION**

The present study shows that *Moringa stenopetala* is a plant easily available in Sille area of Southern Ethiopia and widely used in cooking in the form of three rather similar dishes.

The results in Kemisse area of Northern Ethiopia show a positive response to the dishes when tested out by cooking and serving. All three dishes found in Sille were given a high average score of positive responses of people in the Northern area. Most people wanted to introduce this type of food in their diet if they had access to the plant. These results show that this kind of food rich in antioxidants can be adapted to other places.

A next step would be an intervention study to see whether eating moringa in Northern Ethiopia really can reduce or prevent the development of liver fibrosis. If such an intervention is found effective, it may have a major impact on the public health for people in these areas. Since moringa trees are already found in the North, one can assume that the tree can easily be grown in these areas.

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**Table 1. Average rating on a scale of 0-10 where 0 is the lowest and 10 being the highest score in relation to appearance, smell, consistency, flavor, composition and aftertaste for each dish in Workemado and Cheretee villages (n=85)**

	Kurkufa*	Fosesae*	Kita Be Aleko*
Appearance	8,6	9,1	8,9
Smell	8,7	9,0	9,0
Consistency	8,5	8,9	8,9
Flavor	8,7	9,0	9,1
Composition	9,1	9,5	9,2
Aftertaste	9,0	9,2	9,2
Overall	8,7	9,1	9,0

\*Dishes including *Moringa* plant

**Table 2. Adjusted multiple linear regression of total rating for each dish according to sex, individuals preparing food for the household or not, religion, study site, family size, age and if individuals have tasted moringa before or not in Workemado and Cheretee villages (n=85)**

Variables	Kurkufa*		Fosesae*		Kita Be Aleko*	
	B (95% CI)	P	B (95% CI)	P	B (95% CI)	P
Sex	0.18 (-0.99, 1.36)	0.75	-0.24 (-1.05, 0.56)	0.55	0.18 (-0.88, 1.25)	0.72
Preparing food for family or not	0.28 (-1.11, 1.67)	0.68	-0.18 (-1.12, 0.78)	0.72	-1.37 (-2.63, -0.11)	0.03
Religion	-0.55 (-3.01, 1.90)	0.65	-1.13 (-2.81, 0.55)	0.18	0.01 (-2.20, 2.23)	0.99
Study site	-0.54 (-1.63, 0.53)	0.31	0.05 (-0.68, 0.79)	0.88	0.09 (-0.88, 1.07)	0.84
Family size	-0.07 (-0.33, 0.18)	0.58	0.00 (-0.17, 0.18)	0.96	-0.02 (-0.26, 0.20)	0.81
Age	-0.00 (-0.04, 0.03)	0.70	0.02 (-0.00, 0.05)	0.08	0.01 (-0.02, 0.05)	0.46
Tasted <i>Moringa</i> before or not	-0.48 (-1.96, 2.92)	0.69	1.85 (0.18, 3.53)	0.03	1.52 (-0.68, 3.72)	0.17

\*Dishes including *Moringa* plant.

B= regression coefficients. CI= confidence interval. Significant for P-value < 0.05

Sex: 0= female 1= male

Preparing food for family or not: 0= preparing food for family 1= do not prepare food for family

Religion: 0= Muslim 1= orthodox Christian

Study site: 0= Workemado 1= Cheretee

Family size: continuous variable

Age: continuous variable

Tasted *Moringa* before or not: 0= individuals who have tasted moringa before 1= individuals who have not tasted moringa before

All variables presented are included in the model.





## Dietary Questionnaire in Sille village

Name of interviewer: .....

Study site ..... House Number..... Date .....

1. Family size .....

1.1 Individual code of family member----- Family code-----

1.2 Age ----- Sex----- Religion-----

### 2) Question to individual households preparing *moringa dishes* in Sille

a) How are the moringa dishes prepared in your household? Please describe

Name of moringa dish	Ingredients and amount	Describe procedures of preparation


**3. How often do you use moringa as an ingredient in your cooking? Please tick off**

More than once a day\_\_\_\_ Once daily\_\_\_\_ 1-3 times/week\_\_\_\_

Once weekly \_\_\_\_ 1-2 times a month\_\_\_\_ Less than once a month\_\_\_\_

**4. At what time during the day are dishes containing moringa served? Please tick off**

For breakfast\_\_\_\_ For lunch\_\_\_\_ As a snack\_\_\_\_ For dinner\_\_\_\_

For breakfast and lunch\_\_\_\_ For lunch and dinner\_\_\_\_ For every meal\_\_\_\_

Others\_\_\_\_\_

**5. How do you get access to the leafs from the moringa tree? Please tick off**

I buy them\_\_\_\_ From my own moringa tree\_\_\_\_ Collect from bush\_\_\_\_

Others\_\_\_\_\_

**6. Do you usually pick the leaves on the same day that you use them for cooking?**

Please tick off Yes\_\_\_\_ No\_\_\_\_

## **Dietary Questionnaire in Workemado and Cheretee villages**

Name of interviewer: .....

Study site ..... House Number..... Date .....

1. Family size .....

1.1 Individual code of family member----- Family code-----

1.2 Age ----- Sex----- Religion-----

### **Question to individuals preparing food for the household**

After seeing the procedures for the preparation of the dishes, please answer the following questions:

2. Do you have access to ingredients for making these dishes? Please tick off  
Yes\_\_\_\_ No\_\_\_\_

If No, please explain why?

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3. Do you have kitchenware to make these dishes? Yes\_\_\_\_ No\_\_\_\_

If No, please explain why?

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**4. Would you be able to make some of these dishes? Yes\_\_\_\_\_ No\_\_\_\_\_**

If No, please explain why?

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**5. If you had access to a moringa tree, would you consider including dishes containing this plant in your cooking? Please tick off Yes\_\_\_\_\_ No\_\_\_\_\_**

**6. If you were supposed to use moringa in your daily cooking, how would you prepare a dish containing moringa as an ingredient? Please describe how**

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## **Dietary Questionnaire in Workemado and Cheretee villages**

Name of interviewer: .....

Study site ..... House Number..... Date .....

1. Family size .....

1.1 Individual code of family member----- Family code-----

1.2 Age ----- Sex----- Religion-----

### **Questions to individuals tasting the food**

2. Have you eaten moringa before? Please tick off Yes \_\_\_ No \_\_\_

3. How well did you like each of the dishes?

Please assign a number to each dish on a scale of 0-10 where 0 is "extremely bad" ,  
5 is "middle" and 10 is "very, very good"

<b>Dish</b>	<b>Rating (0-10)</b>
Dish 1	
Dish 2	
Dish 3	

4. How well did you like each dish in relation to each of the items below?

Please assign a number to each dish on a scale of 0 to 10 where 0 is the lowest score,  
5 is the middle and 10 being the highest

<b>Dish 1</b>	<b>Rating (0-10)</b>
Appearance	
Smell	
Consistency	
Flavor	
Composition	
Aftertaste	

<b>Dish 2</b>	<b>Rating (0-10)</b>
Appearance	
Smell	
Consistency	
Flavor	
Composition	
Aftertaste	

<b>Dish 3</b>	<b>Rating (0-10)</b>
Appearance	
Smell	
Consistency	
Flavor	
Composition	
Aftertaste	

**5. Would you consider introducing some of these dishes in your diet if moringa was available? Please tick off**

<b>Dishes</b>	<b>Yes</b>	<b>No</b>
Dish 1		
Dish 2		
Dish 3		

**6. What would you change if you were to eat some of these dishes? Please tick off**

The appearance \_\_\_\_ The smell \_\_\_\_ The consistency \_\_\_\_ The Flavor \_\_\_\_

The composition \_\_\_\_ The aftertaste \_\_\_\_ Another reason \_\_\_\_\_



Appendix 5: Table 1. Unadjusted multiple linear regression

**Table 1. Unadjusted multiple linear regression of total rating for each dish according to sex, individuals preparing food for the household or not, religion, study site, family size, age and if individuals have tasted moringa before or not in Workemado and Cheretee villages (n=85)**

Variables	Kurkufa*		Fosesae*		Kita Be Aleko*	
	B (95% CI)	P	B (95% CI)	P	B (95% CI)	P
Sex	0.15 (-0.87, 1.18)	0.77	-0.50 (-1.25, 0.24)	0.18	-0.33 (-1.29, 0.61)	0.48
Preparing food for family or not	0.37 (-0.78, 1.52)	0.52	-0.44 (-1.29, 0.40)	0.29	-1.28 (-2.32, -0.24)	0.01
Religion	-0.29 (-2.62, 2.02)	0.79	-0.90 (-2.60, 0.79)	0.29	-0.28 (-2.44, 1.87)	0.79
Study site	-0.59 (-1.58, 0.39)	0.23	-0.00 (-0.73, 0.73)	0.99	0.23 (-0.69, 1.16)	0.61
Family size	-0.06 (-0.30, 0.17)	0.60	-0.00 (-0.18, 0.16)	0.93	-0.06 (-0.28, 0.16)	0.58
Age	-0.00 (-0.04, 0.03)	0.87	0.02 (0.00, 0.05)	0.05	0.02 (-0.01, 0.05)	0.26
Tasted <i>Moringa</i> before or not	0.29 (-2.02, 2.62)	0.79	1.68 (0.01, 3.36)	0.04	1.06 (-1.08, 3.21)	0.32

\*Dishes including *Moringa* plant.

B= regression coefficients. CI= confidence interval. Significant for P-value < 0.05

Sex: 0= female 1= male

Preparing food for family or not: 0= preparing food for family 1= do not prepare food for family

Religion: 0= Muslim 1= orthodox Christian

Study site: 0= Workemado 1= Cheretee

Family size: continuous variable

Age: continuous variable

Tasted *Moringa* before or not: 0= individuals who have tasted moringa before 1= individuals who have not tasted moringa before