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SEVENTH FRAMEWORK PROGRAMME

Traditional recipes of millet-, sorghum- and maize-based dishes and related sauces frequently consumed by young children in Burkina Faso and Benin



May 2010

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Introduction

This booklet was elaborated by the team of work package 4 « *Post-harvest processing* » of the European project INSTAPA (http://www.instapa.org/instapa) which aims to identify novel staple food-based strategies to improve micronutrient status of population showing great risk of deficiency (children and women). More precisely, this project focuses on the improvement of millet- sorghum- and/or maize-based foods.
With this objective, authors wanted to identify, characterise the processing methods and assess the nutritional value of the main traditional foodstuffs consumed by children between 6 months and 3 years of age. This booklet collects different recipes of the main cereal-based dishes and their accompanying sauces and aims to describe each of the traditional processing unit steps as well as the type and amount of ingredients used.

The booklet comprises two parts, a first one containing the descriptions and the recipes of the dishes, and a second one containing the nutritional composition of most of these cereal-based dishes and sauces, and corresponding leafy vegetables.

The first part is divided into two chapters: the first one concerns dishes from Burkina Faso and the second one the dishes from Benin. Local names are generally in *Moré* language for recipes from Burkina Faso, and in *Fon* language for recipes from Benin. Inside each chapter a first part is dedicated to cereal-based dishes and a second one to accompanying sauces.
Recipes described here correspond to mean processing methods established from several observations made in field. Owing to the variability of processing methods, we indicated as often as possible the observation frequencies of the use of ingredients and unit steps.
Observations showed a great variability of the processing methods depending on the area. Therefore, the same name can refer to dishes made from different raw materials and/or comprising different processing steps. In such cases, both types of preparation are described in different recipe sheets although the dishes are referred to the same name.

The preparation of sauces requires numerous ingredients. Thereby, when sauces or cereal-based dishes include several ingredients, the list of ingredients is presented by two different ways:

- A first column indicates the mean fresh weight (or wet weight) of ingredients used to make the recipe. This mean value was calculated by counting only the observations where the considered ingredient was used. Thus this first column indicates which quantity (in g) of fresh ingredient (when used) is usually incorporated in the dish described. A diagram nearby the table presents the effective number of times that the ingredient was used in the observations.

- The second column indicates the weight of dry matter (DM) of each ingredient that composes 100g of dry matter of the described dish (expressed as % DM). These data can be used to calculate the mean nutritional composition of the dish. In this case, the mean DM contribution of each ingredient is calculated by counting 0 g for the observations during which the ingredient is not used. The dry matter content of each ingredient was determined during observations or from the food composition table for Mali[1]. These data can be used to calculate the mean nutritional composition of dishes.

[1] *Barikmo I, Ouattara F and Oshaug A (2004). Table de composition des aliments du Mali TACAM, research series N°9; Akershus University College, Oslo.*

Part One

Description of dishes and recipes

I- Recipes from Burkina Faso

I-A. Cereal-based dishes

Millet pancakes (1) - *Massa*

Frying of millet pancakes

Description and uses

Small pancakes made from millet-based dough fried in oil. Often prepared as street food and generally eaten either alone or as small pieces mixed in a gruel such as *ben-saalga* or *ben-kida*.

- **Date and place of observations**: 2008 in Ouagadougou.
- **Number of observations**: 10 observations in small production units.
- **Mean dry matter** content observed as eaten: 59.2%.
- **pH**: not determined

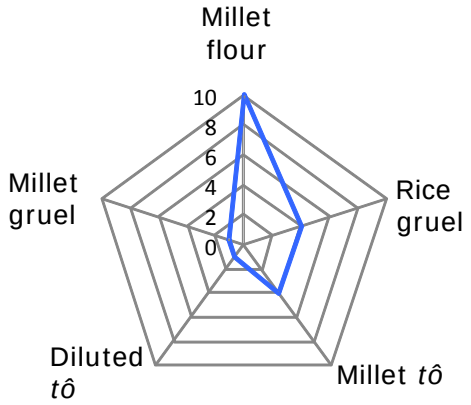
Ingredients

For 1000 g of millet

Ingredients	**Fresh weight** (g)	**%DM****
Millet flour	**1000**	51
Millet flour for *Tô* or gruel	161	4
Rice	112	3
Maize *Tô*	44	0,8
Sugar	439 [177-844]*	22
Oil	390	20
Water	908 [371-1337]	-

**[min – max]*
***dry matter*

Number of observations



Recipe description

Pancakes are made from millet flour and a cereal-based cooked ingredient (generally *Tô*, diluted *Tô*, millet-based gruel or rice-based gruel). These cereal-based ingredients can be prepared specifically for the pancake dough but sometimes the housewives may use any other dish prepared the same day.

- Millet grains are generally dehulled, washed, poured in water and left stand before draining and milling. Most of the time, the resulting flour is sieved.

- To obtain the cereal-based cooked ingredient (several options depending on the recipe used):
  - Rice-based gruel: Cook rice in a large volume of water until getting a gruel (Cooking duration varies from 30 min to 2 h).
  - Diluted *tô*: Dilute pieces of *tô* in about twice more water and mix.
  - *Tô* made specifically for this recipe: Cook about 100 g of millet flour with water. The dough can be decanted at the end of cooking to facilitate the cooling.

- Blend flour (1000 g or 900 g if a part has been used to make *Tô*) with the cereal-based cooked ingredient and water (about 900 mL) and mix well. The obtained dough is then let stand for about 9 hours during which fermentation occurs (final pH of the paste is 4.6 ± 0.6). Afterwards, the sugar is added to the dough as well as water to dilute it and everything is mixed for homogenisation before frying.

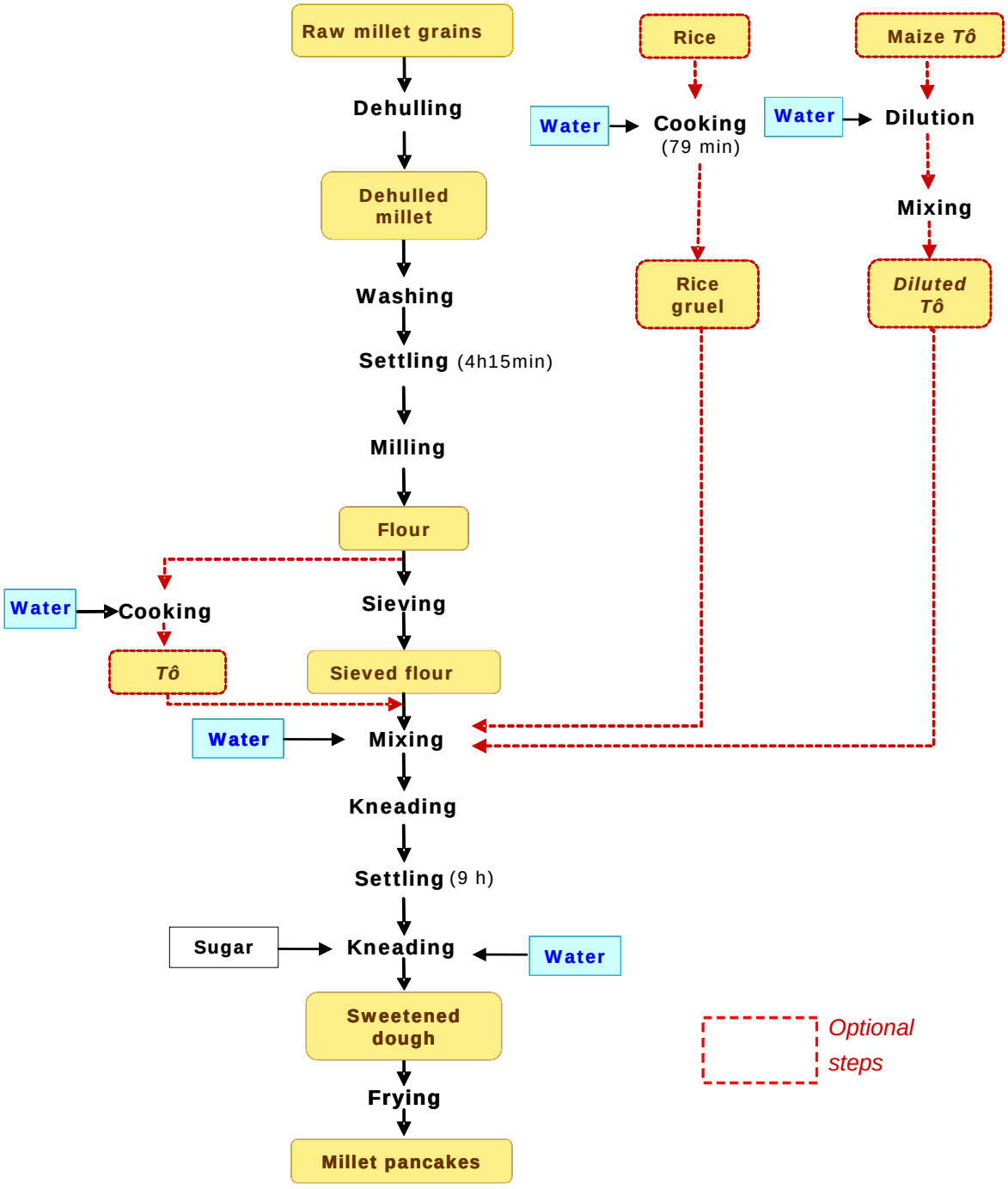
- The mean duration of the process is about 17 hours.

Frequency of observation of the unit steps

Process stage	Number of observations (/10)
Dehulling	2
Winnowing	3
Soaking	3
Washing	8
Draining	6
Settling	6
Grinding	10
Sieving	8
Cooking of intermediate preparations	10
Mixing	10
Resting/ fermentation	10
Mixing with sugar	10
Frying	10

Way of consumption of millet pancakes

Process diagram



References

Sedogo S (2008) Caractérisation des procédés de fabrication de plats traditionnels à base de maïs et sorgho et de leurs sauces. Bachelor report in food technology and nutrition, Lycée agro-environnemental Saint-Joseph du Breuil-sur-Couze / University of Auvergne.

Millet pancakes (2) - *Massa*

Millet pancakes

Description and uses

Small pancakes made from millet-based dough fried in oil. Often found as street food.
In this study, preparations were observed from flour and we do not observe the milling of raw grains.

- **Date and place of observation**: 2008, province of Gnagna.
- **Number of observations**: 6.
- **Mean dry matter content** observed as eaten: 53.4%.

Ingredients

For 1000 g of millet

Ingredients	Fresh weight (g)	% DM
Millet flour (total)	**1000**	77
Preparation 1	151	
Preparation 2	86	
Preparation 3	763	
Sugar	96	8
Oil	176 mL	15
Water	1216 mL	-

Recipe description

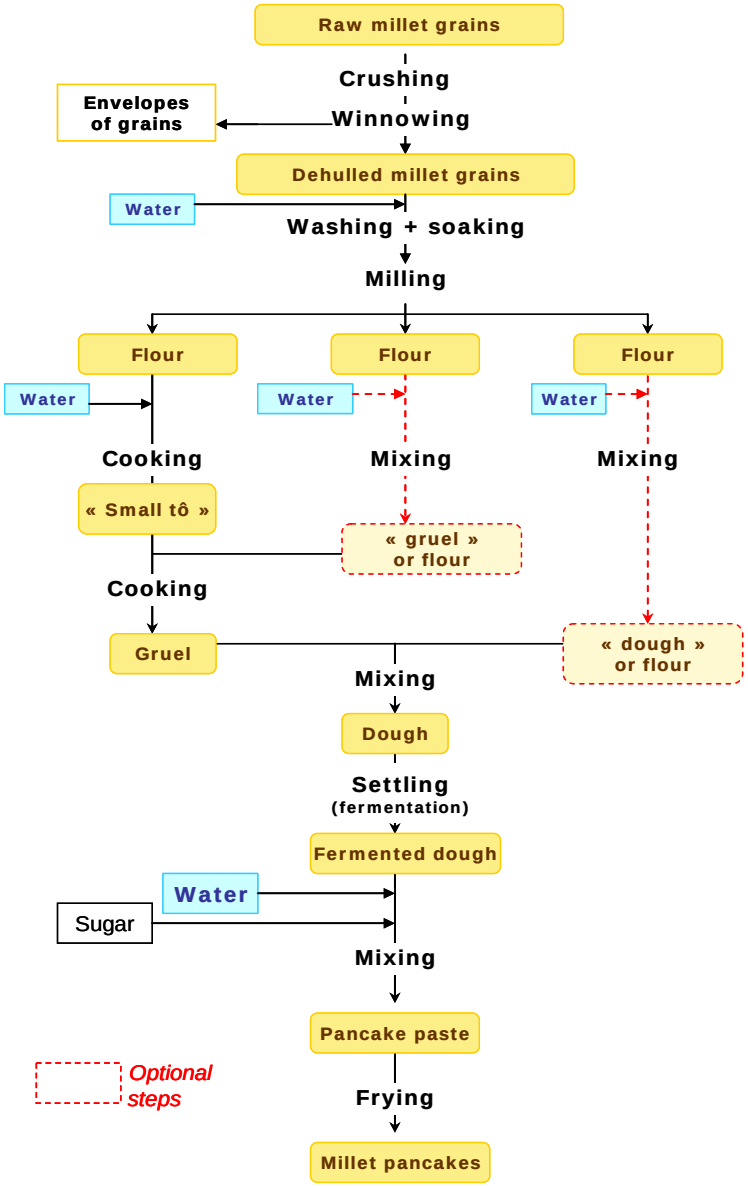
This dish is prepared from millet flour obtained from grains that have been previously dehulled by crushing followed by winnowing. Dehulled grains are then washed and soaked before grinding that is made either with a mortar or with a mill.
Processing comprises 4 main steps:

1. Firstly, mix 150 g of flour with about 160 mL of water in a saucepan. Heat up and let boil for 5 min (*preparation 1, « small tô »*).
2. Secondly, mix 85 g of flour with about 150 mL of water in a bowl. Pour this diluted flour into the saucepan containing the first preparation. Mix and boil for 5 min (*preparation 2, « gruel »*).
3. Then mix the rest of the flour (i.e. about 760 g) with 585 ml of water and blend this mix in the previous preparation (*preparation 3, "dough"*) and let stand the dough for 8 hours at room temperature to obtain fermented dough.
4. Add about 320 g of sugar and 95 ml of water in order to obtain the pancake dough. Take about 60 g of dough and fry with oil for 1 to 2 min.

Frequency of observation of the unit steps

Process stage	Number of observations (/ 6)	Comments
Preparation 1 (“*small tô*”)	6	
Preparation 2 (« gruel »)	4	In two of the observations, the blending of cereal and water was not made so 800 g of flour were directly added to the first preparation instead.
Preparation 3 (“dough”)	3	In 3 of the observations the blending of cereal and water was not made so 800g of flour were directly added to the second preparation instead.

Process diagram



Winnowing of grains

Mixing gruel and “small tô”

Frying of pancake dough

References

Guillot S (2008). Elaboration d’un complément alimentaire pour les enfants de 2 à 6 ans de la province de la Gnagna (Burkina Faso). MSc report. Université Montpellier 1, Université Montpellier 2, SupAgro.

Fermented millet gruel - *Ben-saalga*

Description and uses

Ben-saalga served in a bowl with sugar

Ben-saalga is a semi-liquid millet-based gruel often eaten by the population for breakfast and used as complementary food for children. It is generally found as street food.

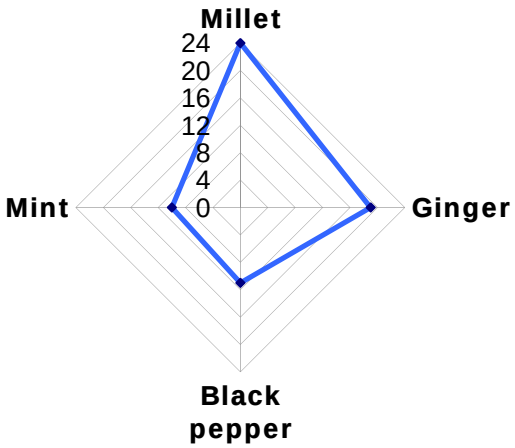
- **Date and place of observation**: 2003 in Ouagadougou.
- **Number of observations**: 24 in traditional production units.
- **Mean dry matter content** observed as eaten: 7.1% without sugar and 10.7% with sugar.
- **pH**: 3.9.

Ingredients

For 1000 g of millet

Ingredients		Fresh weight (g)	%DM
Millet grains		**1000 g**	98.8
Ginger		40	0.9
Black pepper		2.9	0.3
Mint		3.7	0.1
Water	Washing	2191	-
	Soaking	1471	
	Kneading	5618	
	Filtration	5176	
	Settling	5074	
	Cooking	2250	
	Total	**21779**	

Number of observations



Recipe description

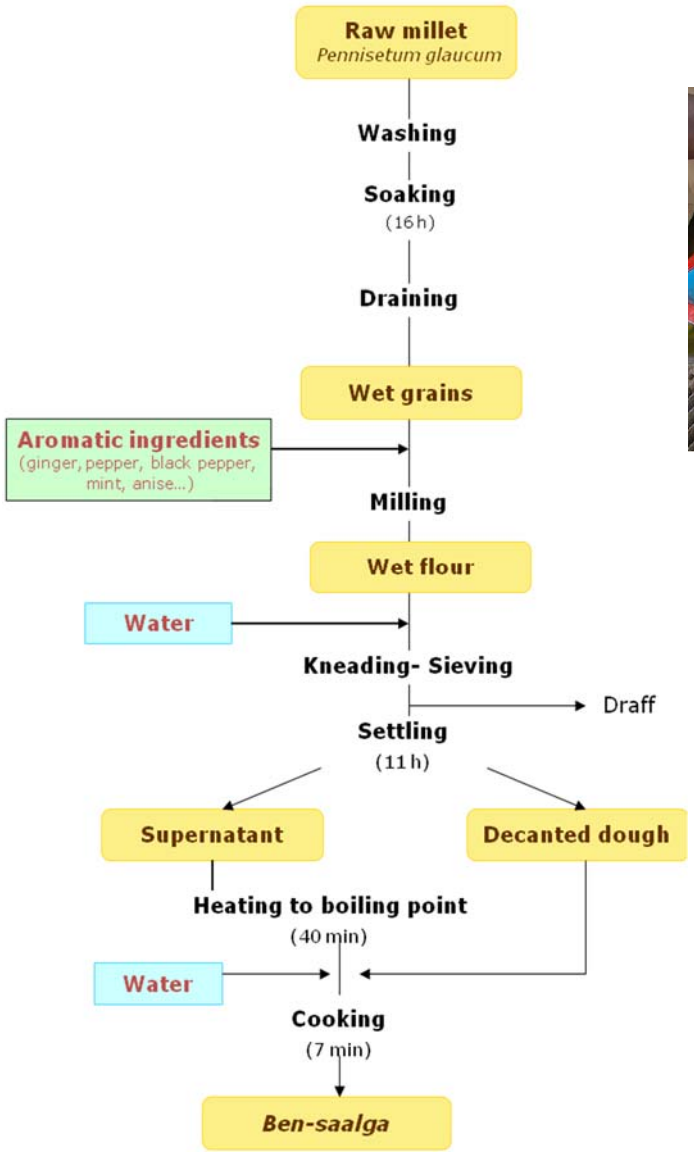
This gruel is made from millet grains generally washed and consistently soaked in water during 16 h on average. Grains are then drained before milling. Aromatic ingredients and spices such like ginger, pepper, or mint are often added to the grains before milling. The resulting wet flour is then mixed with water. The dough is kneaded and filtrated through muslin. This step allows the partial removal of the envelopes of the grains (draff).
Then, let the dough stand for 11 h on average (from 2 h to 20 h depending of the observation). This step results in two phases: thick dough in the bottom of the bowl and a liquid supernatant. Afterward, supernatant is collected and heated to boiling point for

about 40 min. Then, decanted dough is added to the supernatant and everything is heated again for a few minutes (7 min on average).

Frequency of observation of the unit steps

Process stage	Number of observations (/24)
Washing	17
Soaking	24
Kneading	24
Settling	24
Filtration	24
Fermentation	24
Cooking	24

Process diagram



Grinding of wet grains and aromatic ingredients in a mill

Filtration of wet flour

References

Tou EH, Guyot JP, Mouquet-Rivier C, Rochette I, Counil E, Traoré AS, Trèche S (2006) Study through surveys and fermentation kinetics of the traditional processing of pearl millet (*Pennisetum glaucum*) into *ben-saalga*, a fermented gruel from Burkina Faso. I*nternational Journal of Food Microbiology*, Vol 106: 52-60.

Mouquet-Rivier C, Icard-Vernière C, Guyot JP, Tou EH, Rochette I, Trèche S (2008). Consumption pattern, biochemical composition and nutritional value of fermented pearl millet gruels in Burkina Faso, International Journal of Food Sciences and Nutrition, 59(7):716-729.

Cooking of fermented dough

Cooking pot containing ready to eat ben-saalga

Fermented millet gruel with granules - *Ben-kida*

Ben-kida

Description and uses

Le *ben-kida* is a variant of *ben-saalga* containing granules of fermented flour. Often consumed by the population, it is less frequently used as complementary food.

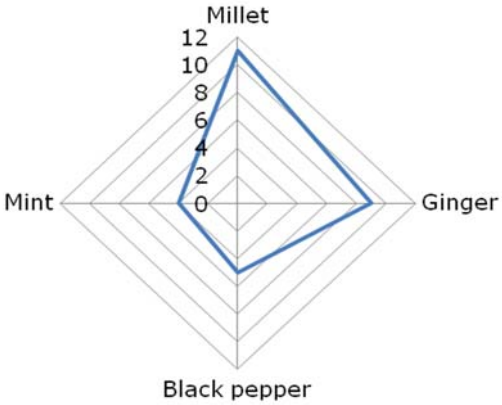
- **Date and place of observation**: 2003 in Ouagadougou.
- **Number of observations**: 11 observations in traditional transformation units.
- **Mean dry matter** observed as eaten: 6.5% without sugar and 10.7% with sugar.
- **pH**: 4.0.

Ingredients

For 1000 g of millet

Ingredients	Fresh weight (g)	%DM
Millet flour	**1000**	98.8
Millet granules	323	
Ginger	40	0.9
Pepper	2.9	0.3
Mint	3.7	0.1
Water	Not determined	-

Number of observations



Recipe description

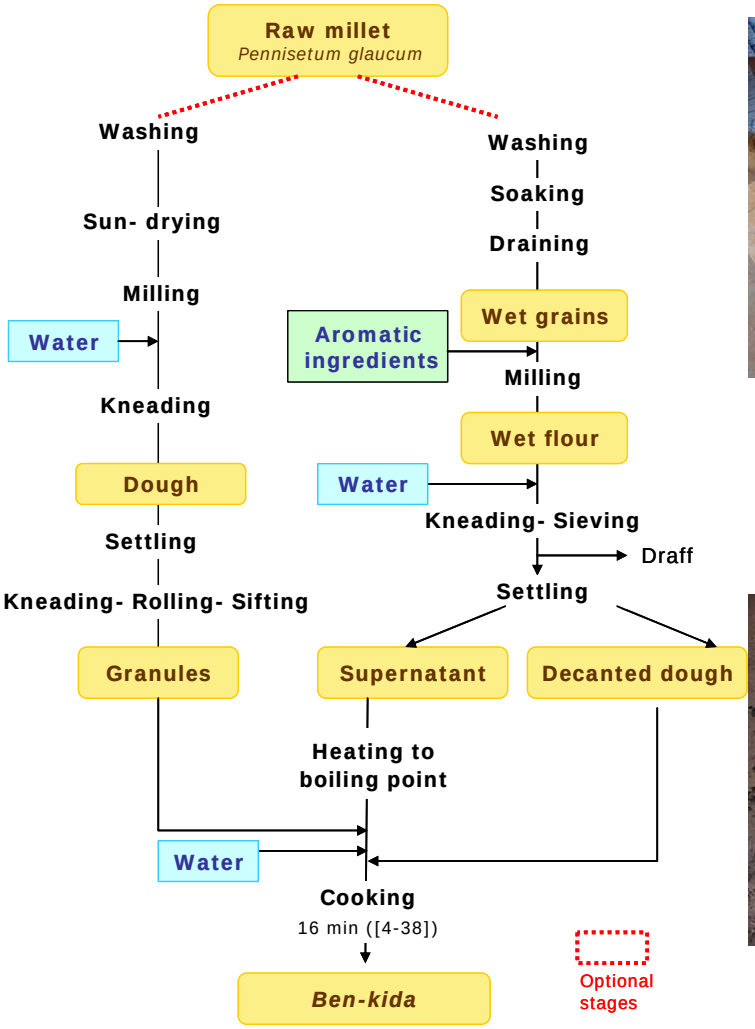
- Granules preparation:

Raw millet is usually washed with water and sun-dried before milling. Afterward, water is added and the mix is kneaded to obtain wet flour that is let stand for few hours. The next step aims at shaping the granules by successive operations: the dough is kneaded and portions of the dough are rolled to form granules that are finally sifted.

- Final preparation of *ben-kida*:

These granules are added to the supernatant obtained for the preparation of *ben-saalga* (see previous recipe) that was first heated to boiling point. Water and decanted dough prepared for the *ben-saalga* are added and everything is cooked for 16 min on average.

Process diagram



Making of granules by kneading and sifting

Granules

References

Cerefer (2003). Meeting consumer requirements for cereal based fermented foodstuffs with improved nutritional and sanitary quality and shelf-life in Africa. First annual report of the 381 Cerefer project, European Union, contract number ICA4-CT2002-10047.

Mouquet-Rivier C, Icard-Vernière C, Guyot JP, Tou EH, Rochette I, Trèche S (2008). Consumption pattern, biochemical composition and nutritional value of fermented pearl millet gruels in Burkina Faso, International Journal of Food Sciences and Nutrition, 59(7):716-729.

Urban Area

Millet gruel (North region)

Description and uses

This porridge is of semi-liquid and homogeneous consistency made from cereal flour. It can be prepared either in household or in small processing units. It is usually eat for breakfast and as complementary feeding. Final product can be flavored with fermented milk, sugar, ginger, tamarind, baobab pulp, oil, etc. The present description concerns household gruels made for infant and young children.

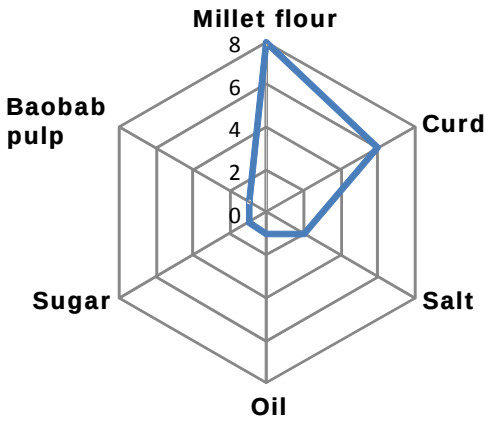
- **Date and place of observation**s: 2009, in Dori.
- **Number of observations**: in 8 households.
- **Mean dry matter content** as eaten: 9.1%.

Ingredients

For 1000 g of millet

Ingredients	Fresh weight (g)	% DM
Millet flour	**1000**	90
Sugar	868	6
Curd	440	3
Baobab pulp	90	1
Oil	44	0.3
Salt	23	1
Water	9611	-

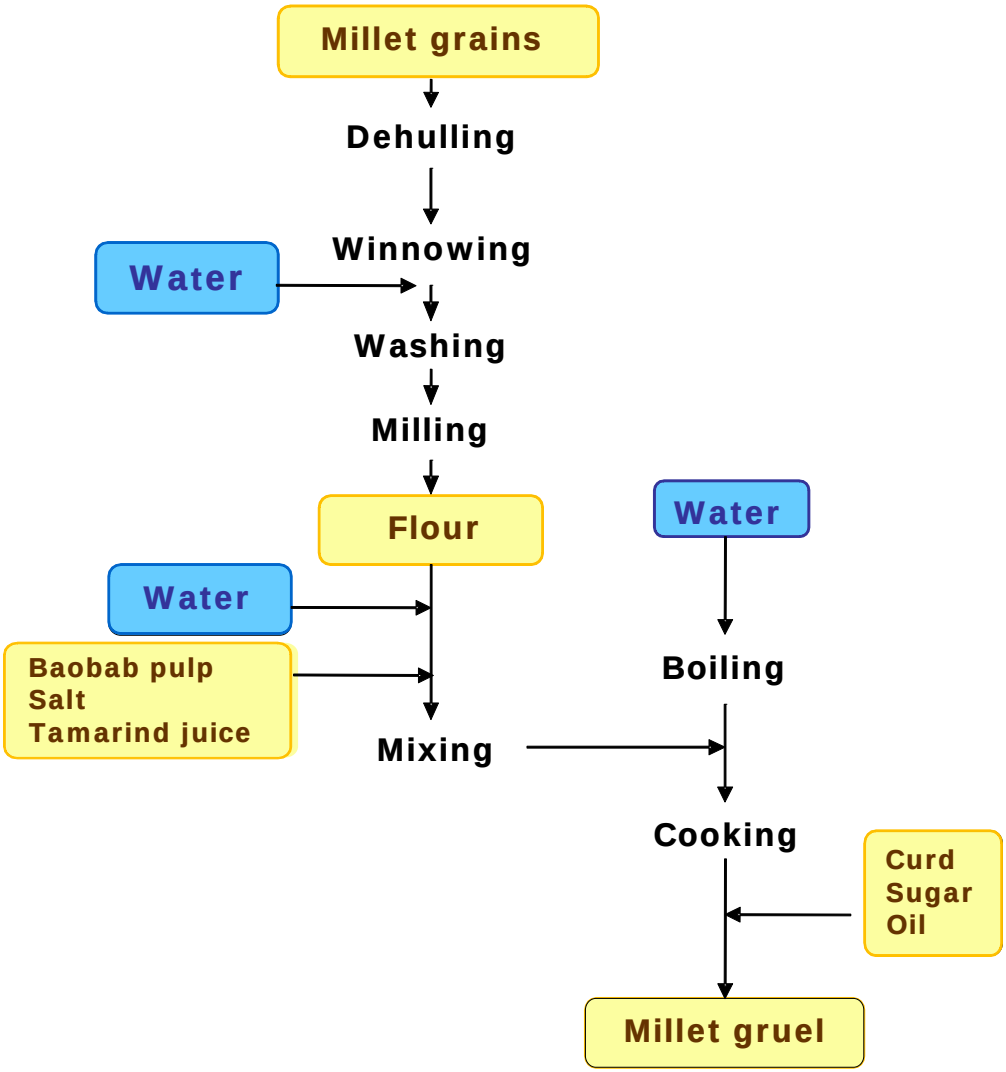
Number of observations



Recipe description

Millet grains are dehulled manually or mechanically. They are winnowed and washed in water and then processed into flour in pestle and mortar or in a mill.
In a pot, water is brought to the boil. A mix of flour, fresh water, baobab pulp, sugar or curd is poured into boiling water. Everything is mixed until to obtain a light and homogeneous gruel. The gruel is ready to eat after 5 to 10 min of boiling.

Process diagram



Urban area

Sorghum gruel (North region)

Description and uses

Gruels can also be made from sorghum, according to a process similar to the one used for millet gruel preparation. It can be prepared either in household or in small processing units. It is usually eat for breakfast and as complementary feeding. Final product can be flavored with fermented milk, sugar, ginger, tamarind, baobab pulp, oil, etc. The present description concerns household gruels made for infant and young children.

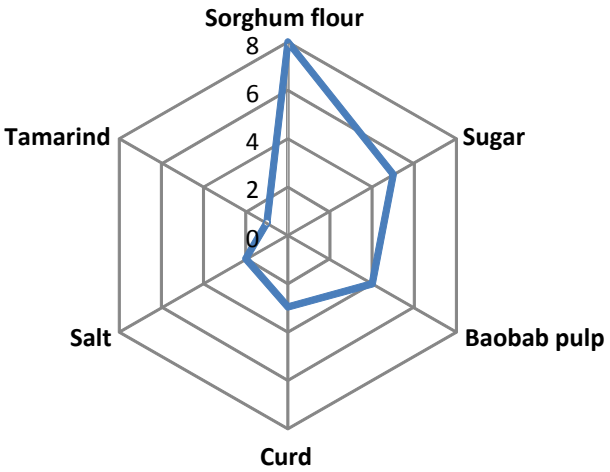
- **Date and place of observation**: 2009, in Dori.
- **Number of observations**: in 8 households.
- **Dry matter content** as eaten: 8.6%.

Ingredients

For 1000 g of sorghum

Ingredients	Fresh weight (g)	% DM
Sorghum flour	**1000**	84
Curd	477	2
Sugar	264	14
Baobab pulp	Not determined	-
Salt	6	0.5
Tamarind juice	Not determined	-
Water	9756	-

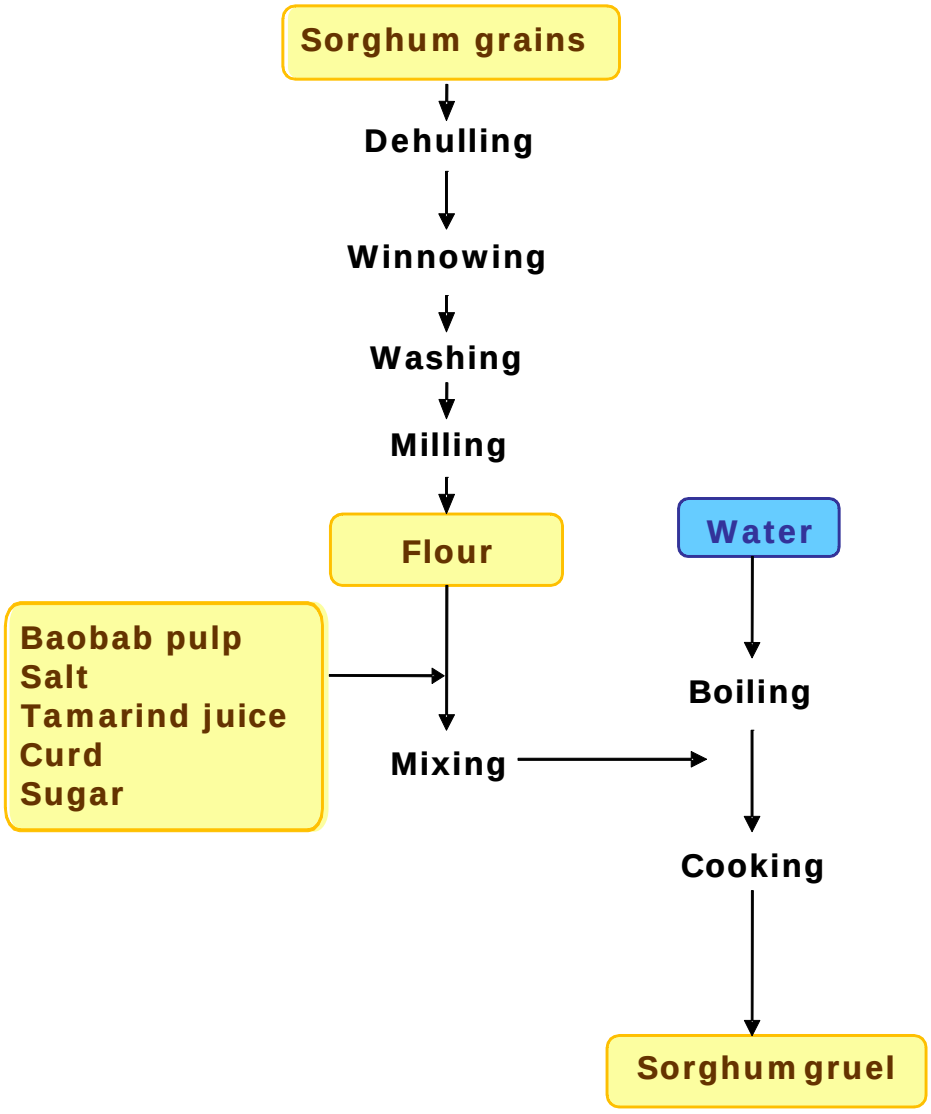
Number of observations



Recipe description

Sorghum grains are dehulled manually or mechanically. They are winnowed and washed in water and then processed into flour in pestle and mortar or in a mill.
In a pot, water is brought to the boil. A mix of flour, fresh water, baobab pulp, sugar or curd is poured into boiling water. Everything is mixed until to obtain a light and homogeneous gruel. The gruel is ready to eat after 10m of boiling.

Process diagram



White maize paste – Maize *Tô*

White maize tô served with leafy vegetable sauce

Description and uses

Thick dough made from flour cooked with water and shaped as balls. Very popular in Burkina Faso, it is eaten daily by all the population with different sauces.
White maize *tô* is more frequently eaten in urban areas, whereas in rural areas, *tô* is made with other cereals such as millet or white sorghum and less frequently red sorghum.

- **Date and place of observation**: 2008 in Ouagadougou.
- **Number of observations**: 10 observations in households.
- **Mean dry matter** observed as eaten: 16.2%,
- **pH**: 4.6.

Ingredients

For 1000 g of dehulled maize

Ingredients	Fresh weight (g)
Maize flour	**1000**
Water	3981

Recipe description

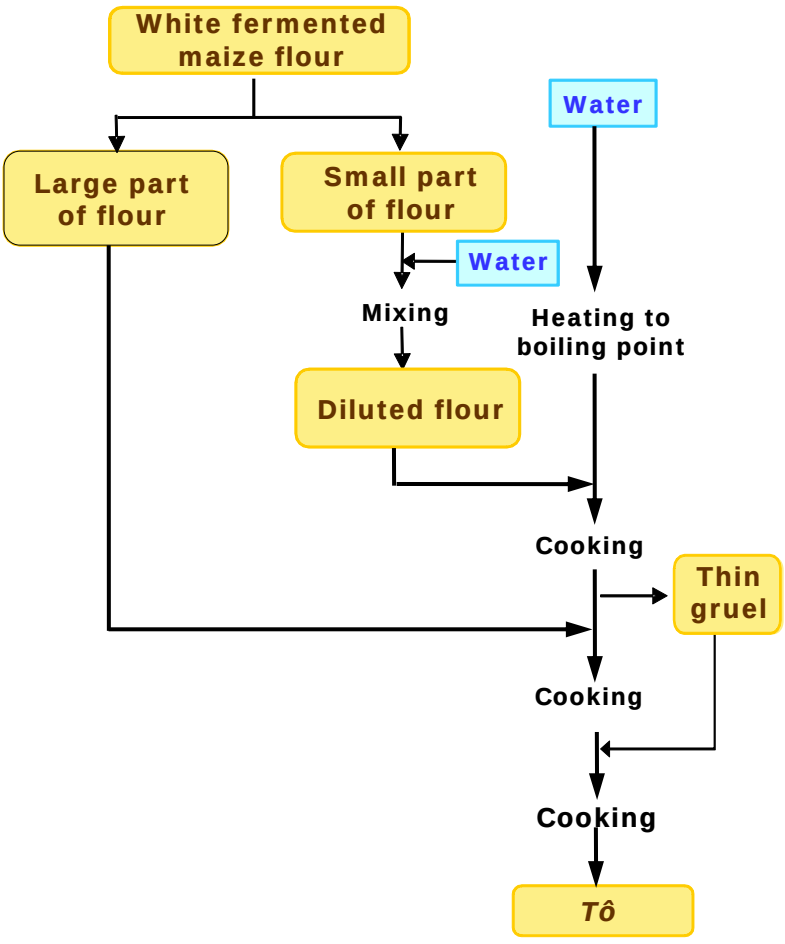
In 7 cases out of 10, maize *Tô* was prepared from maize flour. Different ingredients such as lemon juice, vinegar or tamarind leaf juice are sometimes added. These ingredients give a sour taste to the *Tô*.

- Before grinding, maize grains are often dehulled and soaked overnight. During soaking, fermentation starts. After drying, soaked grains are grinded to give flour that is kept several days in the household.
- About 2/3 of the flour is put aside (« large part of flour»). The remaining third of flour (small part) is diluted in cold water (about 1/5 of the total)
- A large part of water (about 4/5 of the total) is heated to the boiling point in a cooking pot and the “diluted flour” is added and cooked for 15 min in mixing well.
- A part (about 1/3) of the resulting « thin gruel » is put aside in a bowl.
- The “large part of flour” is immediately added to the cooking pot and everything is cooked for around 4 min after vigorous mixing.
- In the following step, the « thin gruel » is progressively added to the previous preparation, and everything is vigorously mixed and cooked for 7 min.
- Balls are then shaped with a ladle.

Frequency of observation of the unit steps

Process stage	Number of observations (/10)
Dehulling	3/10 (7 unknowns)
Soaking	2/10 (7 unknowns)
Grinding	10
Cooking	10

Process diagram



Thin gruel

Vigorous mixing after addition of the "large part of flour"

References

Sedogo S (2008) Caractérisation des procédés de fabrication de plats traditionnels à base de maïs et sorgho et de leurs sauces. Bachelor report in food technology and nutrition, Lycée agro-environnemental Saint-Joseph du Breuil-sur-Couze / University of Auvergne.

Sorghum paste – Sorghum *Tô*

Description and uses

Red sorghum Tô

Tô is a thick paste made from different cereals and generally eated with a sauce. It is the most popular dish in Burkina Faso.
It is eaten by young children as soon as they are able to eat family dishes.

- **Date and place of observation**: 2009 in Dori.
- **Number of observations**: 5 in households.
- **Dry matter content as eaten**: 22.9%.

Ingredients

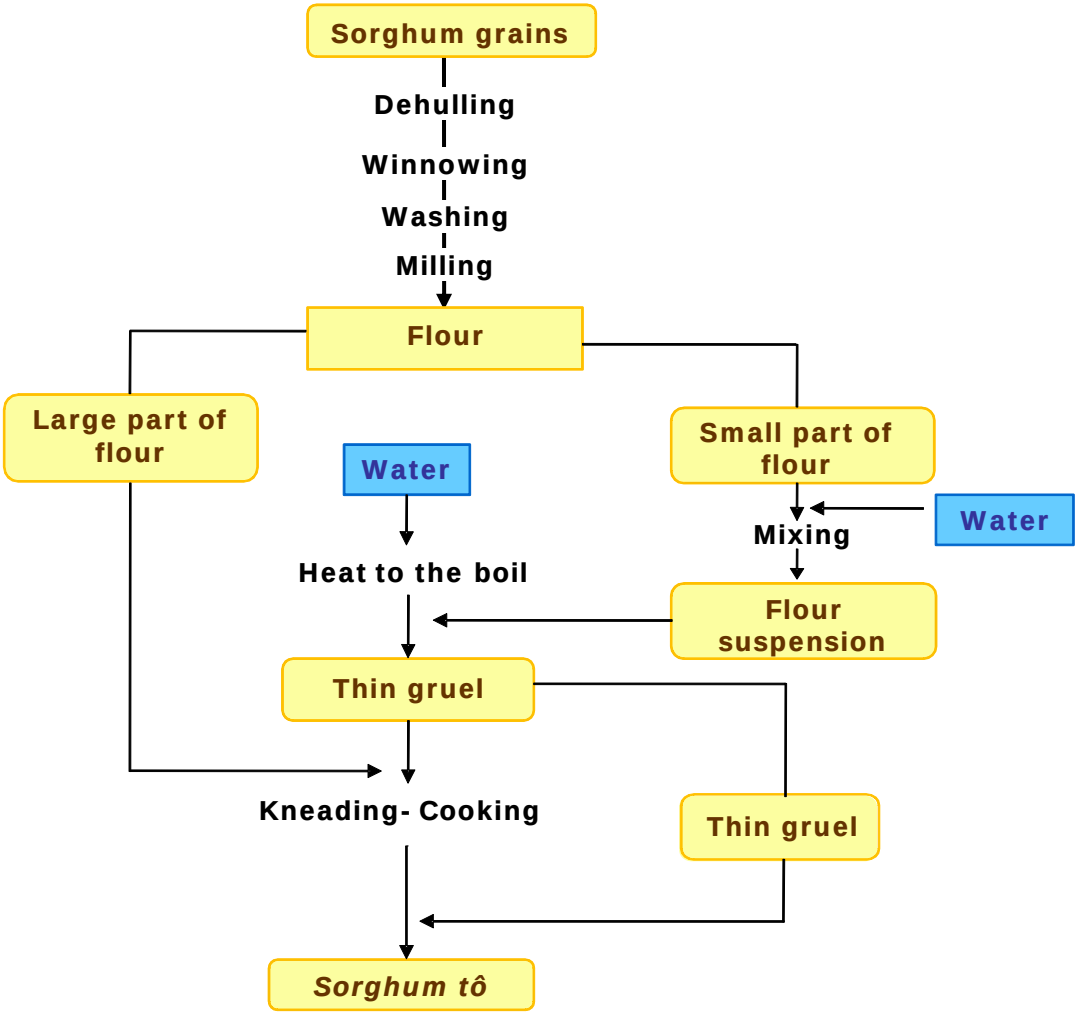
For 1000 g of sorghum

Ingredients	**Fresh weight** (g)
Sorghum flour	**1000**
Water	2251

Recipe description

Sorghum *tô* is prepared from sorghum flour, water and other acidifying ingredients. Flour is obtained by crushing the dehulled and washed grains in mortar or in a mil. Water is brought to the boil in a pot.
A small part of the flour (around 1/3 of total flour) is diluted in water to obtain a « flour milk ». This flour suspension is poured into boiled water and mixed until a light gruel is formed. After cooking for 5 to 10 min, part of the gruel is taken off the pot and the large part of the flour (around 2/3) is added to the pot. Everything is thoroughly mixed for 15 min until the paste get thicker. The light gruel previously removed is progressively (2 to 3 times) incorporated into the pot while mixing. Cooking is carried on for 15 to 20 min until the dough gets a thick consistency. Tô is then served with a wooden ladle to give it a rounded shape.

Process diagram



Cooking of tô

Millet paste - Millet *Tô*

Description and uses

Tô is a thick dough made from different cereals and generally eat with a sauce. It is the most popular dish in Burkina Faso. It is eaten by young children as soon as they are able to eat family dishes.

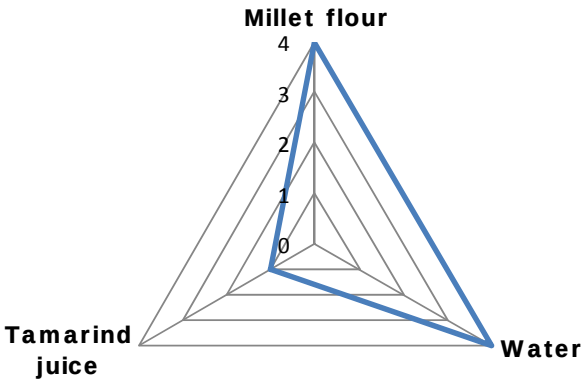
- **Date and place of observation**: 2009, in Dori.
- **Number of observations**: 4 in households.
- **Dry matter content as eaten**: 19.9%.

Ingredients

For 1000 g of millet

Ingredients	Fresh weight (g)
Millet flour	**1000**
Water	2535
Tamarind juice	160

Number of observation

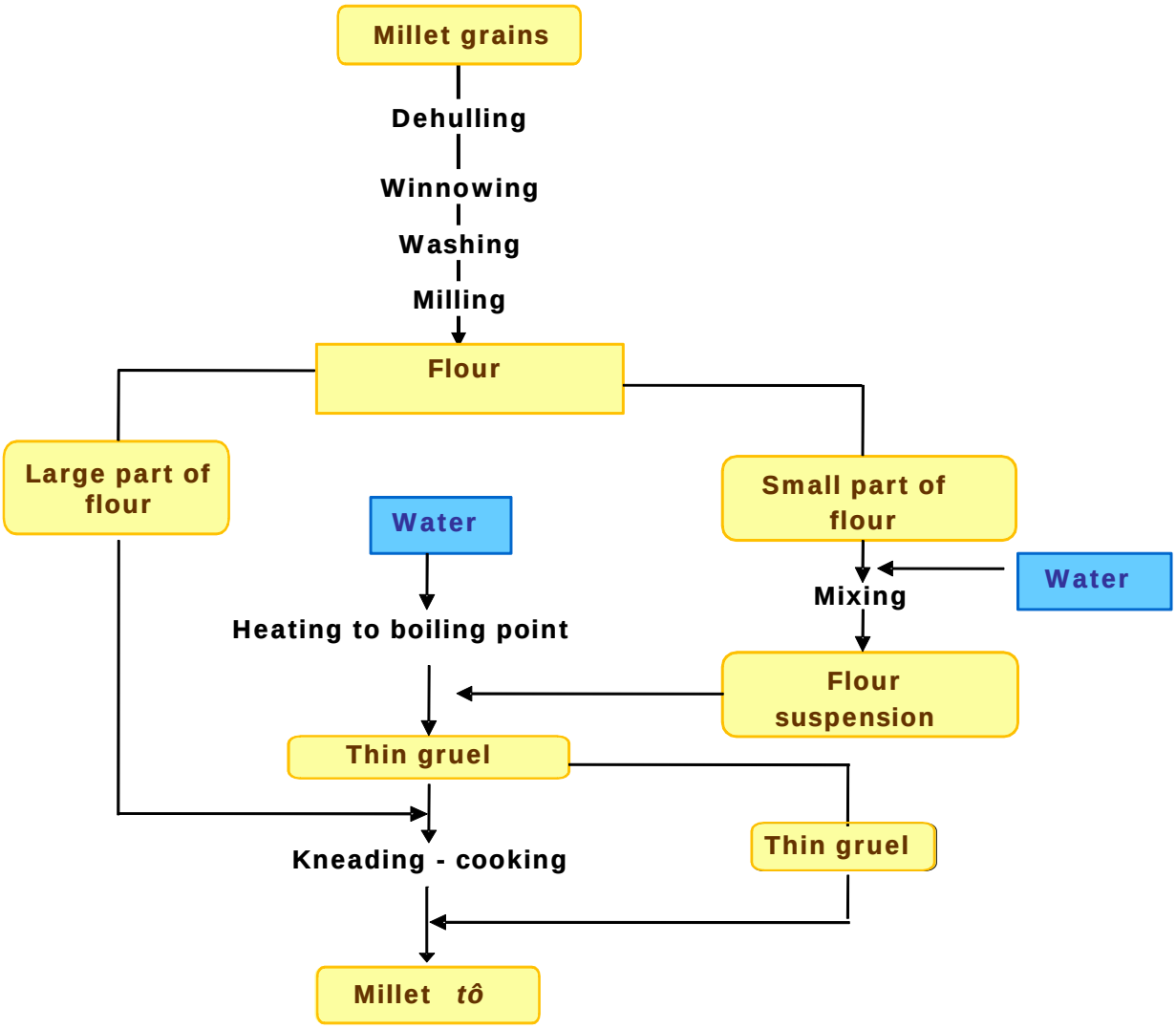


Recipe description

Tô is made with millet flour obtained from whole or dehulled grains. Dehulling can be made manually or mechanically and grains are winnowed to remove envelopes. Grains are then washed and partially dried before milling.

To prepare *tô*, water is brought to the boil in a cooking pot. Sometimes tamarind juice can be added. A small part of the flour (around 1/3 of total flour) is diluted in water to obtain a « flour milk ». This flour suspension is poured into boiled water and mixed until a light gruel is formed. After cooking for 5 to 10min, part of the gruel is taken off the pot and the big part of the flour is added to the pot. Everything is thoroughly mixed for 15 min until the paste get thicker. The light gruel previously removed is progressively incorporated into the pot while mixing. Cooking is carried on for 15 to 20 min until the dough gets a thick consistency.

Process diagram



Pouring flour suspension in boiling water

Addition of the large part of millet flour in the thin gruel and mixing

Mixing and thickening of millet tô during cooking

Diluted sorghum or millet *Tô*

Tô délayé

Description and uses

Diluted *tô* is a liquid gruel obtained by addition of water to *tô*. It is commonly used as complementary food for young children.

- **Date and place of observation**: 2008 in the province of Gnagna.
- **Number of observations**: 22 from sorghum *tô* and 8 from millet *tô*, in households.
- **Mean dry matter content** observed as eaten: 15.9% (with sugar).

Ingredients

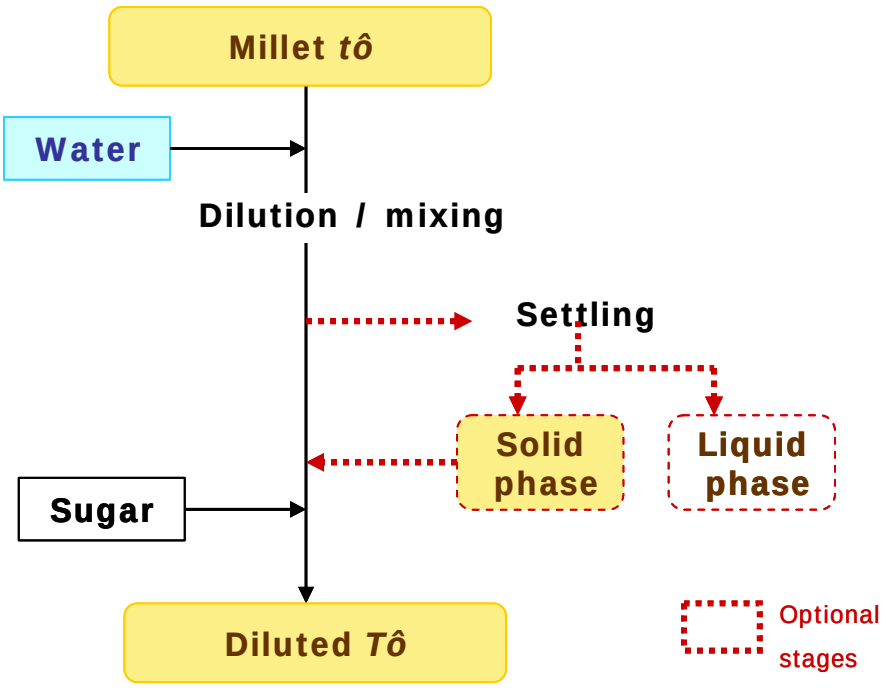
For 1000 g of millet or sorghum tô

Ingredients		Fresh weight (g)	%DM
Sorghum or millet *Tô*	Without settling	**1000**	65
	With settling	**1000**	82
Sugar	Without settling	123	35
	With settling	46	18
Water	Without settling	1277	-
	With settling	3518	-

Recipe description

Diluted *tô* is a liquid gruel obtained by addition of water to the *tô,* at room temperature. Sugar is also added to the mix.
The processing of diluted *tô* includes sometimes a settling step. In this case, the amount of water added is about three times greater than in the case of preparation without settling.
At the end of the settling step, supernatant is discarded and the thick lower phase is eaten after addition of sugar. The amount of sugar used is higher when the settling stage is applied.

Process diagram



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Crude millet beverage - *Zom-kom*

Ingredients and cookware for zom-kom

Description and uses

Sweetened beverage made with uncooked millet and sugar, and often aromatic ingredients. It is often drunk by the population and bought in the street.

- **Date and place of observation**: 2008, in Ouagadougou.
- **Number of observations**: 9 observations in small production units and 1 in a household.
- **Mean dry matter content** observed as eaten: 14.4%.
- **pH**: 3.5.

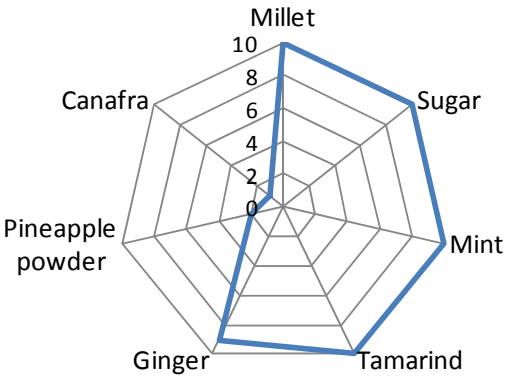
Ingredients

For 1000 g of millet

Ingredients		Fresh weight (g)	% DM
Millet		**1000**	24
Sugar		2633	73
Ginger		165	0.8
Mint		70	0.3
Tamarind	leaves	228	0.6
	fruits	233	0.8
Pineapple powder		8	<0.1
Canafra[1]		6	<0.1
Water		nd	-

[1]*unidentified spice*

Number of observations



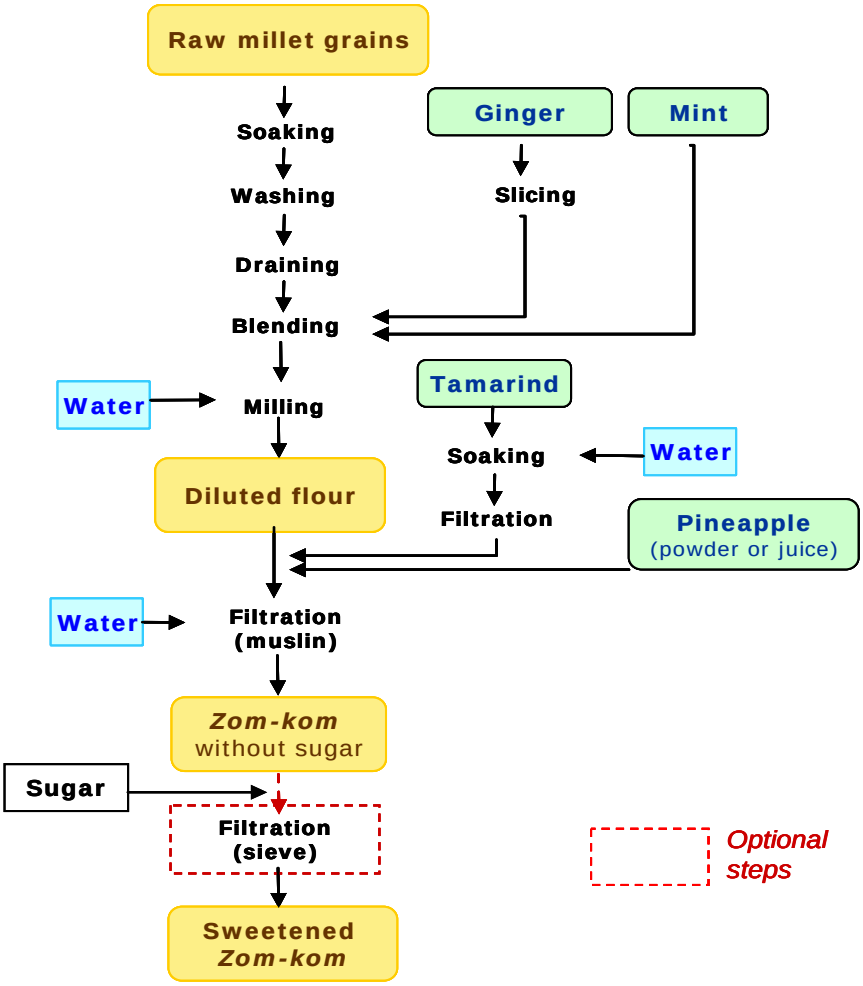
Recipe description

- Firstly, tamarind fruits or leaves are soaked during 1 h15 min or 45 min respectively. The tamarind extract is then filtered and put aside.
- Millet grains are washed and soaked for about 14 h and drained.
- Aromatic ingredients (ginger, mint,…) are washed and mixed with grains
- This mix is grinded after adding water and the tamarind extract. Draffs are discarded by filtration of the mix through a piece of muslin. Sugar and other optional ingredients are added and the mix may be filtrated a second time.
- The desired consistency is obtained by dilution with cold water.

Frequency of observation of the unit steps

Process stage	Number of observations (/10)
Washing	10
Soaking	10
Draining	10
Grinding (grains+ingredients)	10
Filtration 1	10
Settling	1
Filtration 2	7
Filtration 3	1
Dilution	10

Process diagram



Filtration with muslin

Addition of sugar

References

Sedogo S (2008) Caractérisation des procédés de fabrication de plats traditionnels à base de maïs et sorgho et de leurs sauces. Bachelor report in food technology and nutrition, Lycée agro-environnemental Saint-Joseph du Breuil-sur-Couze / University of Auvergne.

Urban area

Whole millet or bran millet beverage - *Tounka*

Description and uses

La *tounka* is a beverage prepared either from millet bran or from whole millet flour, with addition of potash, salt and sugar. This beverage is prepared at home mainly by the *fulani* population. Considered as a nutritious beverage, it is often prepared for vulnerable groups such as young children and lactating women.

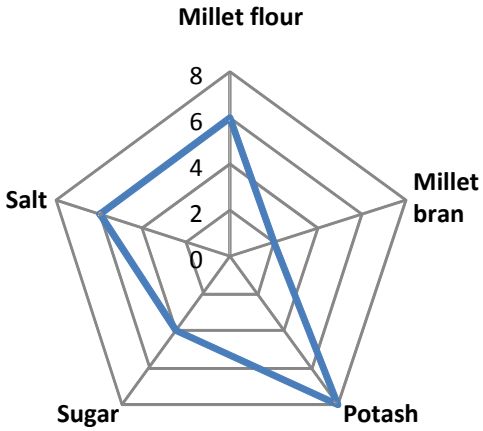
- **Date and place of observation**: 2009, in Dori and surrounding area.
- **Number of observations**: 8 in households.
- **Mean dry matter content** as eaten: 24.7%.

Ingredients

For 1000 g of millet flour or millet bran

Ingredients	Fresh weight (g)	% DM
Millet flour	**1000**	94
Millet bran	1000	-
Sugar	69	3
Salt	15	1
Solid potash	11	1
Water	1933	-

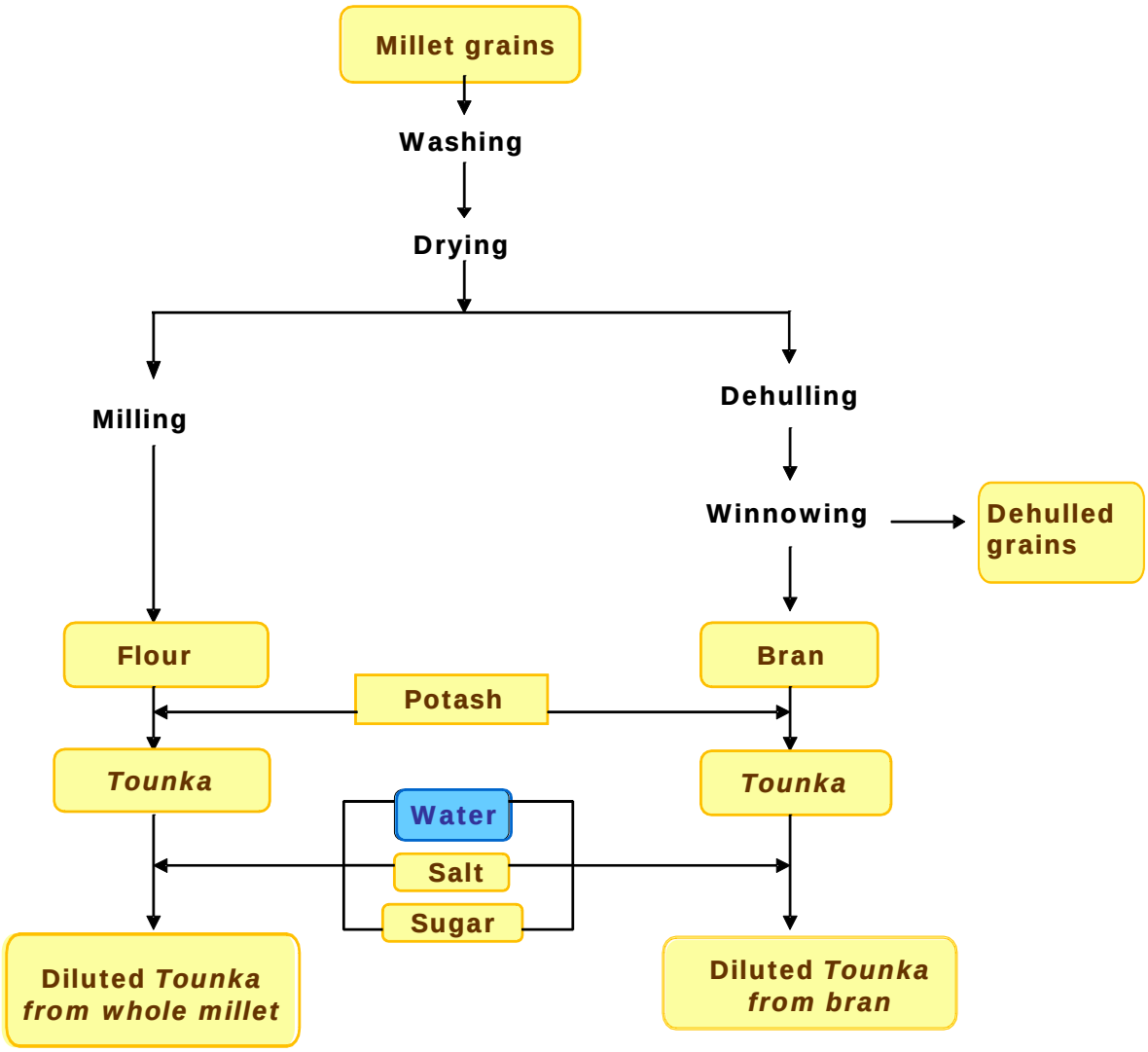
Number of observations



Recipe description

The *tounka* can be prepared either from whole millet flour or from millet bran obtained by winnowing millet after dehulling. Bran or whole millet flour is added with potash to obtain the *tounka*. Before consumption, water, salt and sugar are added to obtain the ready-to-eat diluted *tounka*.

Process diagram



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Rural area

Fatty rice

Description and uses

Rice-based dish often eat for lunch or dinner and sometimes for breakfast.

- **Date and place of observation**: 2003, Province of Boulgou (Ouarégou).
- **Number of observations**: 6 in households.
- **Mean dry matter content** observed as eaten: 31.7%.

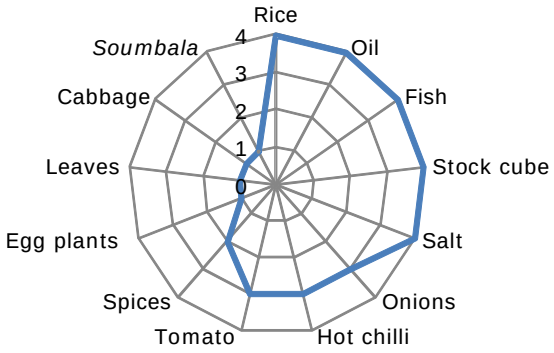
Ingredients

For 1000 g of rice

Ingredients		Fresh weight (g)	%DM
Rice		**1000**	65
Oil		479	24
Dried fish		68	4
Stock cube		22	2
Salt		20	1
Fresh onion		184	1
Hot chilli pepper, dried		4	0.2
Tomato	fresh	92	0.1
	purée	78	0.2
Rocou (tomato powder)		35	1
Spices		19	1
Eggplant		432	1
Bama* leaves		250	0.4
Cabbage		136	0.3
Soumbala		25	0.5

**Unidentified vegetable*

Number of observations



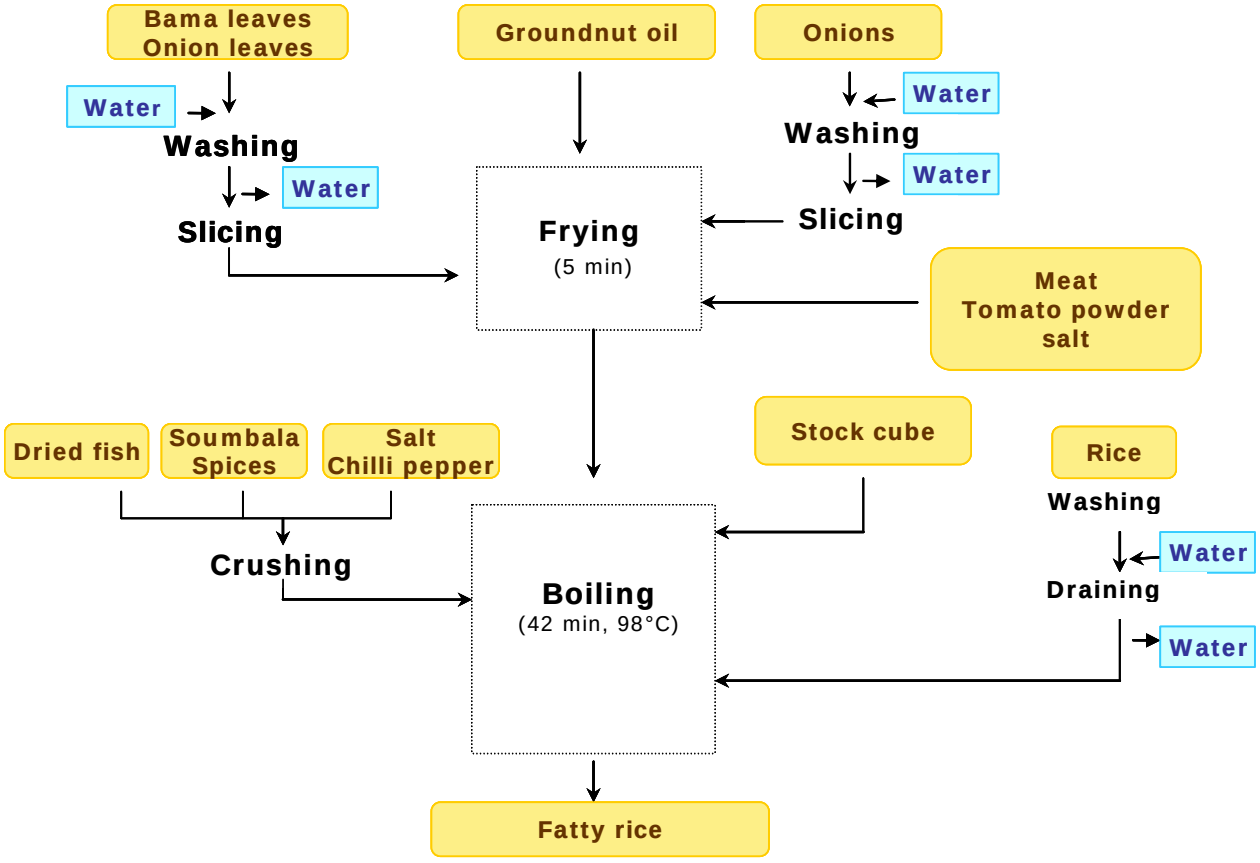
Frequency of observation of the unit steps

Process stage	Number of observations (/6)
Frying	6
Boiling	6
Washing of rice	4
Washing	4
Slicing	4
Crushing	3
Washing of leaves	1

Recipe description

- Washed and sliced onions are fried in a cooking pot with meat, salt and tomato purée. About 6 min later, water, stock cube and crushed ingredients (dried fish, spices, *soumbala*, chilli pepper) are added.
- White rice is washed, drained and poured in the cooking pot. The mix is boiled for about 39 minutes. Wood or coal fire is used for the cooking.

Process diagram



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Avallone S, Brault S, Mouquet C, Treche S (2007) Home-processing of the dishes constituting the main sources of micronutrients in the diet of preschool children in rural Burkina Faso. International Journal of Food Sciences et Nutrition, 58, 2, 108-115.

Brault S (2003) Identification et description des modes de préparation des aliments constituent des sources potentielles en fer, zinc et vitamine A dans l'alimentation des enfants de 1 à 5 ans dans le village de Ouaregou au Burkina Faso. MSc report. University of Montpellier 2, France, 52 p.

Millet dough - *Tchobal* or *Fura*

Description and uses

Tchobal is a very thick dough made from millet flour. Flour and water are mixed and shaped with the hands to form balls cooked in boiling water. This dish is very popular in Sahel area where it is often eaten with curd cheese mixed with water and sugar. *Tchobal* can also be designated as *fura* in several regions.

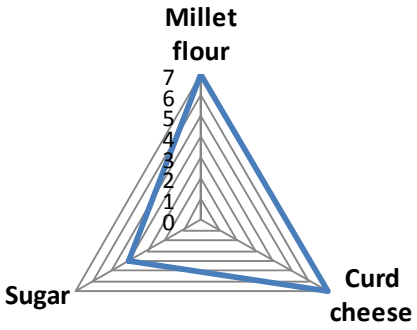
- **Date and place of observation**: 2009, in Dori.
- **Number of observations**: 7 in households.
- **Mean dry matter content as eaten**: 22.0% before addition of sugar or milk.

Ingredients

For 1000 g of millet

Ingredients	Fresh weight (g)	%DM
Millet flour	**1000**	97
Curd cheese	208	3
Sugar	13	0.6
Water for mixing	111	-
Water for dilution	257	-

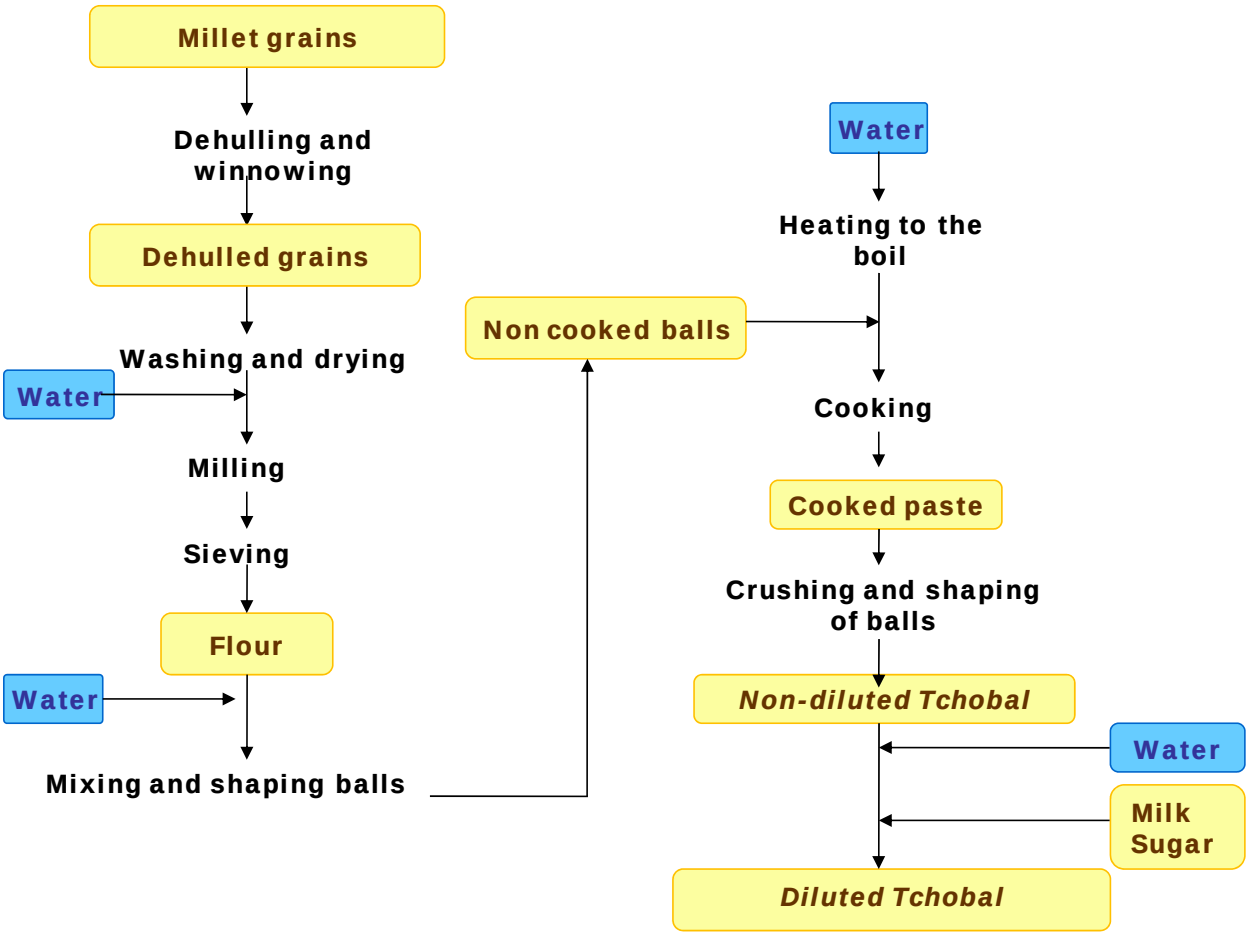
Number of observations



Recipe description

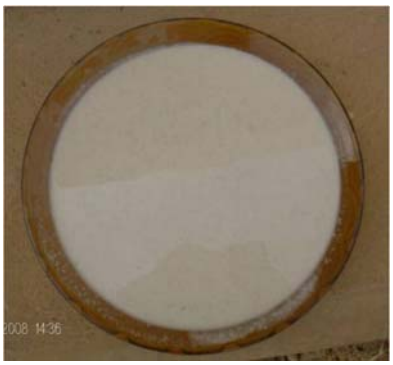
Millet grains are first manually or mechanically dehulled and then winnowed and washed before being processed into flour using a mill or a mortar. The flour obtained is sieved and humidified with cold water. Then, balls of 2 to 4 cm diameter are shaped with the hands.
These balls are cooked in boiling water for about 15 min. After cooking, balls are crushed again with a pestle in a mortar with small amount of hot water. Balls are shaped with the hands again to obtain the *tchob*al paste. Milk (curdled or not), water and sugar are added to the paste before consumption to obtain the diluted *tchobal* paste.

Process diagram



Millet dough with milk - *Gappal*

Description and uses



Gappal

Gappal is a dough of semi-liquid consistency prepared from millet flour of very fine grading and with curdled milk or yoghurt. This dish is very popular in the north region where it is almost daily eaten by children as well as adults.

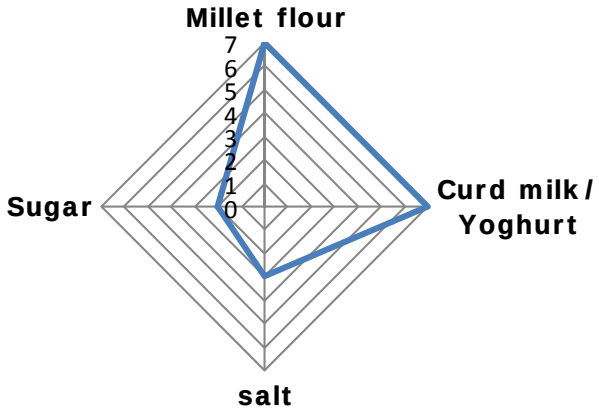
- **Date and place of observation**: 2009, in Dori.
- **Number of observations**: 7 in households.
- **Mean dry matter content** as eaten: 37.6% with milk and/or sugar.

Ingredients

For 1000 g of millet

Ingredients	Fresh weight (g)	%DM
Millet flour	**1000**	93.6
Curdled milk or yoghurt	269	4.8
Sugar	80	2.5
Salt	nd	-
Water (for crushing)	375	-
Water (for dilution)	215	-

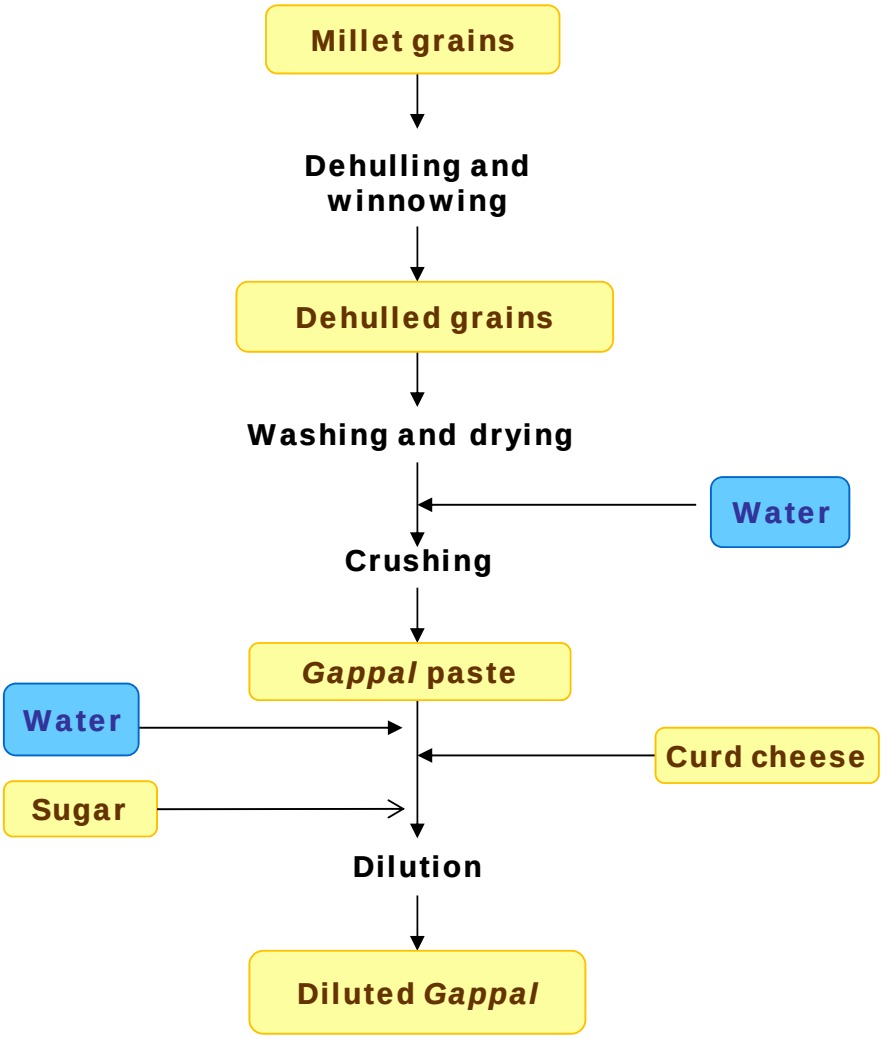
Number of observations



Recipe description

To prepare *gappal*, millet grains are dehulled manually or mechanically. Grains are then winnowed, washed and dried. Dried grains are crushed in a mortar with a pestle after adding a small amount of water. A thick dough is obtained that could be diluted into curd cheese and water as well as sugar to obtain the *gappal*.

Process diagram



Millet flour

Urban area

Millet couscous

Description and uses

Couscous is granular steamed food, very popular in West Africa where it is prepared with millet, maize, sorghum or fonio. Millet couscous is usually eaten with a groundnut-based sauce accompanied by fish or meat, legumes or vegetables. It can also be eaten with milk (fermented or not) and added with sugar.

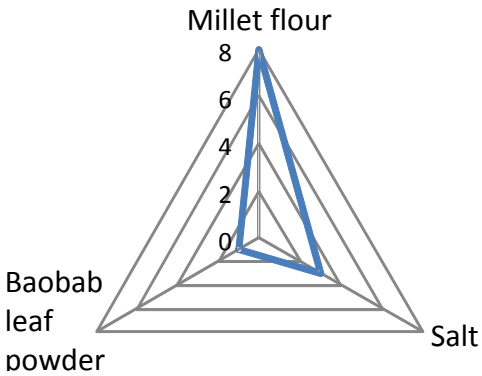
- **Date and place of observations**: 2009, in Dori.
- **Number of observations**: 8 in households.
- **Mean dry matter content** as eaten: not determined.

Ingredients

For 1000 g of millet

Ingredients	Fresh weight (g)
Millet flour	**1000**
Water	368
Salt	3
Baobab leaf or okra powder	Not determined

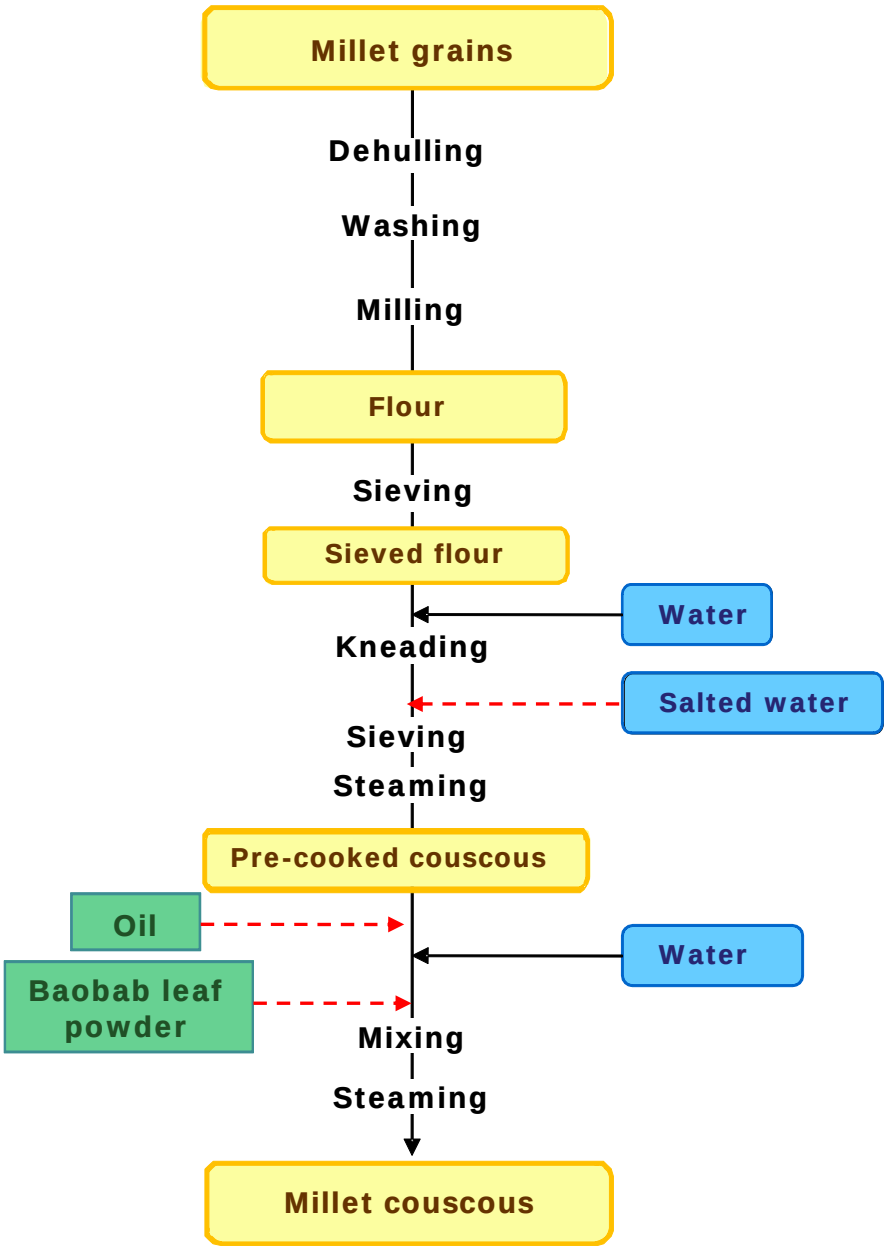
Number of observations



Description de la recette

Millet grains are dehulled, winnowed, washed and milled into fine flour sieved through a 1mm sieve. Flour is then mixed with a small amount of water usually in a calabash to form a paste. This paste is then sieved (1.5mm sieve) to form small granules. Granules are then steamed 3 times of 15-20 min in a specific cooking pot called “couscoussier”. Between 2 steaming stages, granules are broken up manually. Just before the last steaming phase, baobab leaf powder, okra powder, salt and/or oil can be added to the granules. Once cooked, couscous is served with groundnut sauce. It can also be sun-dried to preserve it for around 6 months. Once it is dried, couscous is prepared by steaming or by absorption of milk.

Process diagram



I-B. Sauces

Ingredient description

Ingredients of plant origin

Vernacular name	Name in *Moré*	Latin name	Description
Ethiopian eggplant	*Kumba*	*Solanum incanum/ aethiopicum*	Plant grown for its fruits. The dark green leaves are used to make sauces.
Baobab	*Touega - toega*	*Adansonia digitata*	Baobab leaves can be used to make sauces in fresh or dried form. Baobab fruit contains seeds embedded in a dry white pulp with acidulated taste (very rich in vitamin C). This pulp can be eaten as it is or incorporated into sauces. Seeds can also be used to make fermented paste looking like *soumbala*.
Jute	*Bulvaka*	*Corchorus olitorius*	Seasonal herbaceous plant. Leaves are used fresh or dried to make sauces and give to it a creamy texture.
Ginger		*Zingiber officinale*	Ginger is a root commonly used to flavor dishes and sauces or to make beverages.
Okra	*Maana*	*Abelmoschus esculentus*	Plant in the *mallow* family comprising several annual or perennial varieties. Fruits, fresh or after drying, are often used as ingredients for sauces giving them a characteristic slimy texture. Okra fruit can also be eaten as vegetables after boiling in water.
Kapok		*Ceiba pentandra*	Dried calyces of kapok's flowers used as ingredient in sauces Seeds can also be used for cooking.
Cowpea	*Bengedo*	*Vigna unguiculata*	Legume plant which leaves and seeds are used to make sauces.
Roselle Sorrel	*Bito, wegda, dâ*	*Hibiscus sp (sabdariffa)*	Roselle corresponds to herbaceous seasonal plant grown in the beginning of dry season. Leaves are used fresh or dried. Roselle and sorrel are used here to describe the same plant at different growing stages. In the market small leaves and large leaves are sold separately. They present different morphology but seems to belong to the same plant (not confirmed)
Tamarind		*Tamarindus indica*	Sour and acidic pulp extracted from the tamarind (*Tamarindus indica*) fruit. The tamarind juice is obtained by soaking the pods in water following by pressing to extract the juice.
Chilli pepper	Kiparé	*Capsicum frutescens*	Plant giving fruits of variable size depending on the variety considered. Fresh or dried fruits are used as condiment to cook sauces.
Cassia tora leaves	*kiri-kiri, sogoda, sokoto*	*Cassia tora*	*Cassia tora* is a wild shrub. The leaves are used to prepare sauces.

Condiments

English name	Moré name	Description
Fermented roselle powder	*Bikalga*	Condiment made from fermented roselle seeds (*Hibiscus sabdariffa*).
Fermented *néré* seeds	*Soumbala*	Condiment obtained after alkaline fermentation of dehulled seeds of *néré (Parkia biglobosa)*. The obtained paste is usually shaped in balls.
Rocou	Tomato powder	This condiment may correspond to *Bixa orellana* (Achiote) powder. This powder is obtained from the wax coating the seeds and it contains great amount of carotenoids.
Tomato purée		Paste obtained from tomatoes that are cooked until the water content reach around 70%. It is often bought in the market and is used as basis for several sauces and dishes.
Groundnut balls	Koura-Koura	groundnut *(Arachis hypogea L.)* oil cake
Groundnut paste		Thick paste obtained from groundnuts *(Arachis hypogea L.)* after blanching and/or roasting and fine grinding.
Potash (liquid) = Ash extract		Akaline liquid (pH ≈ 11) obtained by filtration of a blend of water and ash resulting from the calcination of cereal stems.
Potash (solid)		Stone-like compound, often sold in markets and used as ingredient to make sauces. It is obtained by the dehydration of an extract of ashes of sorghum or millet stems.
Glutamate		White powder usually used as flavour enhancer to make sauces.

Dried okra sauce (1)

Dried okra pod slices

Description and uses

Semi-liquid slimy sauce frequently eaten by the population with millet-based-*tô* at lunch or dinner.

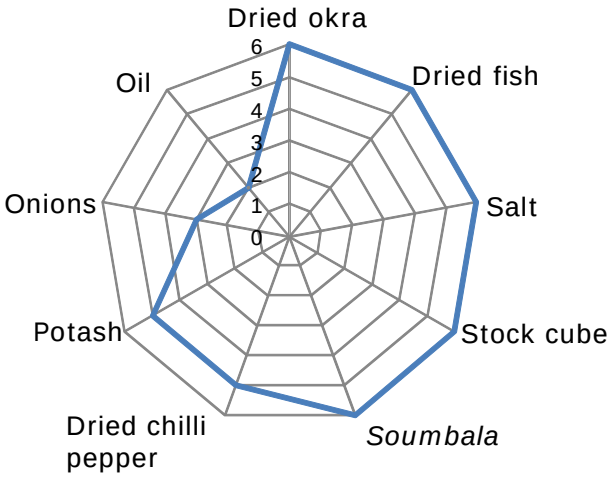
- **Date and place of observation**: 2003, Province of Boulgou (Ouarégou).
- **Number of observations**: 6.
- **Mean dry matter content** of the product as eaten: 12.5%.

Ingredients

For 100 g of dried okra

Ingredients		Fresh weight (g)	% DM
Dried okra		**100**	35
Dried fish		44	13
Salt		25	9
Stock cube		27	9
Soumbala		68	19
Dried Chilli pepper		3	1
Potash	liquid	55	0.01
	solid	9	5
Onion		244	4
Groundnut oil		65	7

Number of observations



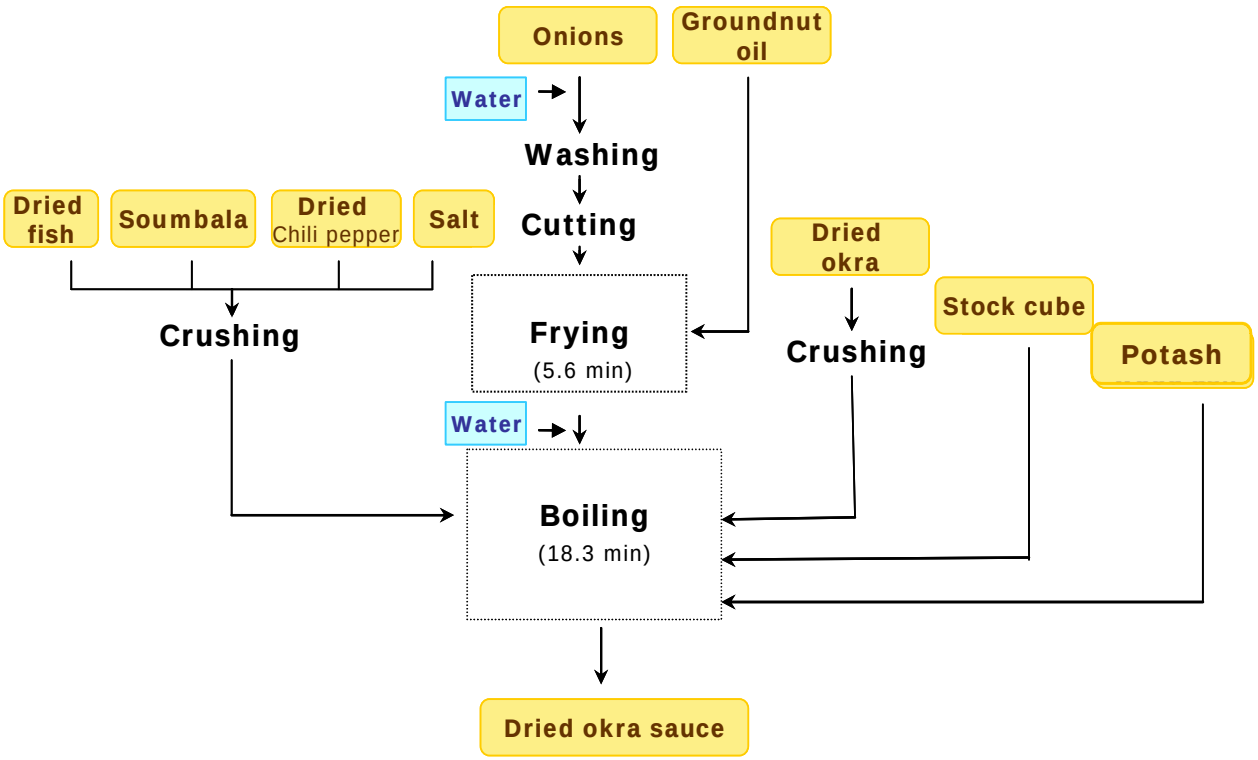
Recipe description

Dried fish, *soumbala*, dried chilli pepper and salt were crushed with a pestle in a mortar. Water was added and sometimes fried onions. Crushed dried okra was then added as well as stock cube and extract of wood ash. Everything was brought to the boil and cooked for 20 minutes in an aluminium pot and over a wood fire.

Frequency of observations of unit steps

Process stage	Number of observations (/ 6)
Boiling	6
Grinding	6
Addition of potash	5
Frying	2

Process diagram



References

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Brault S (2003). Identification et description des modes de préparation des aliments constituent des sources potentielles en fer, zinc et vitamine A dans l'alimentation des enfants de 1 à 5 ans dans le village de Ouaregou au Burkina Faso. MSc report. University of Montpellier 2, France, 52 p.

Dried okra sauce (2)

Description and uses

Sauces made with dried okra are various and very popular in Burkina Faso. Most often they accompany cereal-based dishes such as rice or *tô*. Okra gives to the sauces a very characteristic slimy texture.

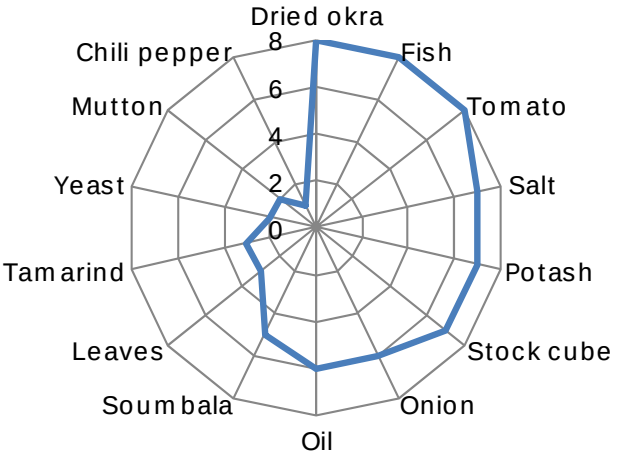
- **Date and place of observations**: 2008 in Ouagadougou.
- **Number of observations**: 7 observations in households.
- **Mean dry matter content** of the product as eaten: 11.5%.
- **pH**: 7.1 (one observation)

Ingredients

For 100 g dried okra

Ingredients		Fresh weight (g)	% DM
Dried okra		**100**	26
Fish	dried, smoked	53	10
	fresh	30	0.3
Tomato	fresh	263	4
	purée	35	1
Tamarind	dried fruit	322	12
	sweetened juice	625	6
Salt		30	6
Stock cube		27	5
Potash (solid)		12	0.1
Onion or shallot		186	4
Oil		73	14
Soumbala		44	4
Aubergine or onion leaves		383	1
Yeast		48	2
Mutton		214	4
Hot chilli pepper		3	<0.1

Number of observations

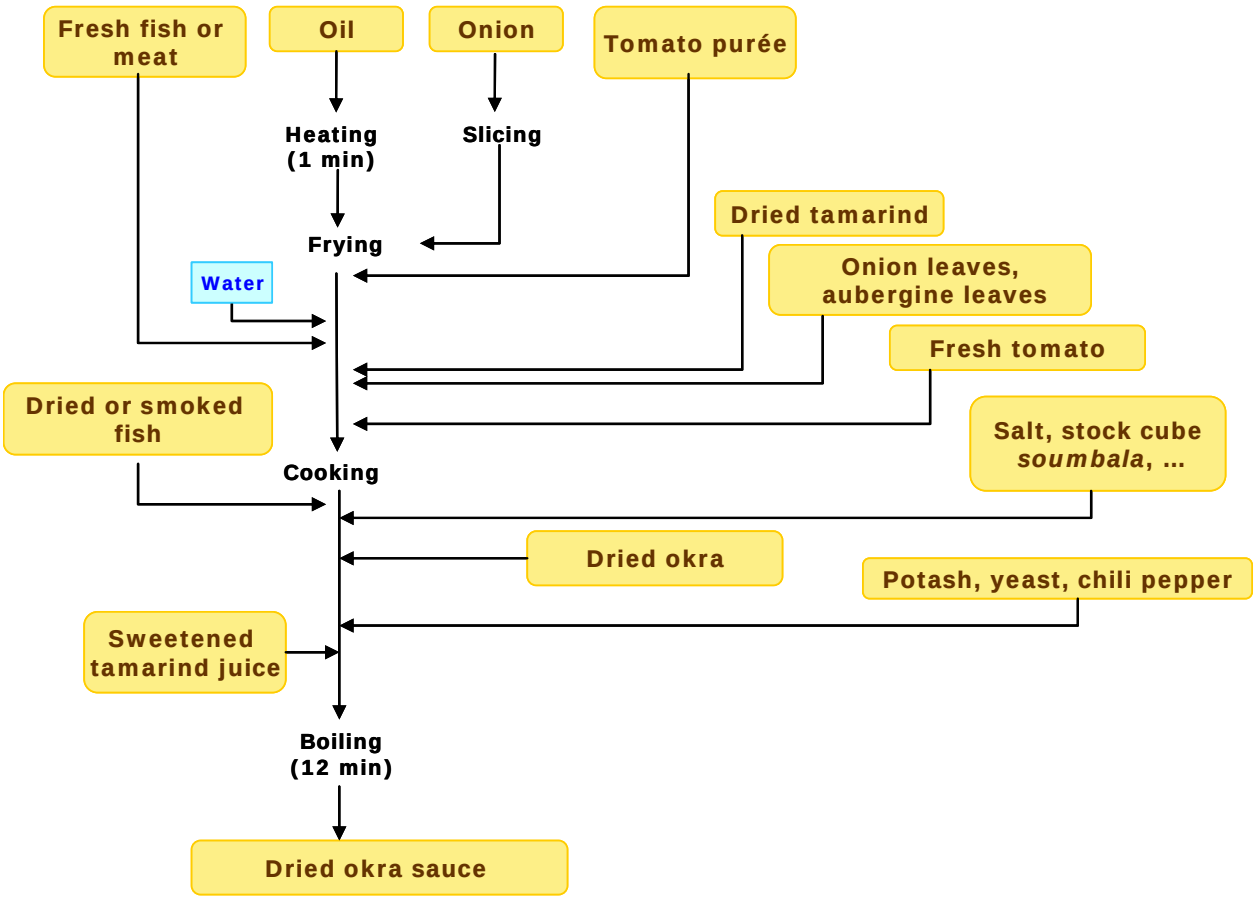


Dried okra pods

Recipe description

Heat up the oil in a pot before adding onions and cook for about 3 min. If available, add tomato puree and cook for 4 min.
Then add water and fresh fish or meat. Add tamarind together with aubergine or onion leaves (optional) and sliced fresh tomatoes. Then successively add the following ingredients (cooking for 2 to 3 min between the addition of each ingredient): dried or smoked fish, salt, stock cube, *soumbala*, dried okra; potash, yeast, hot Chilli pepper and possibly the tamarind juice. Cook for about 12 min.

Process diagram



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Baille B (2008). Evaluation de la couverture des besoins en énergie, fer, zinc et vitamine A par l'alimentation chez les enfants de 1 à 5 ans en zone urbaine (Ouagadougou, Burkina Faso) et estimation de la participation des plats à base de mil, sorgho, maïs et manioc. MSc report. University of Montpellier 2, France. 77 p.

Fresh okra sauce

Description and uses

This sauce is a variant to the previous one which is made with dried okra. It generally accompanies cereal-based dishes.

- **Date and place of observations**: 2008 in Ouagadougou.
- **Number of observations**: 7 observations in households.
- **Mean dry matter content** of the product as eaten: 12.0%.
- **Mean pH**: 6.2 (3 observations)

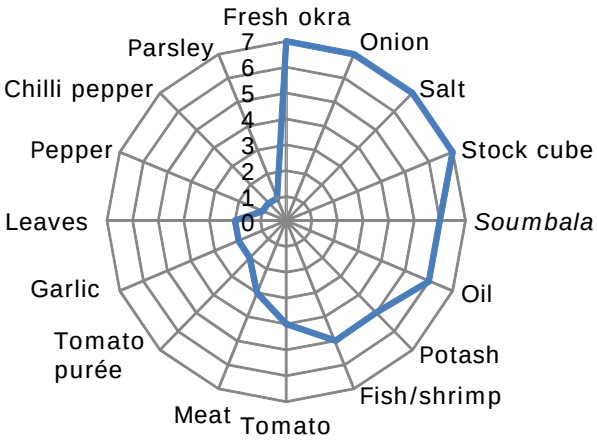
Ingredients

For 300 g of fresh okra

Ingredients		Fresh weight (g)	%DM
Okra		**300**	27
Onion		56	5
Salt		7	5
Stock cube		11	9
Soumbala		14	6
Oil		36	18
Tomato	Purée	38	2
	Fresh	75	1
Potash (solid)		3	0,1
Fish	Dried	14	5
	Smoked	30	1
	Fresh	150	5
Dried shrimp		16	1
Meat	Beef	104	7
	Mutton	87	4
Garlic		7	0,4
Cowpea or jute leaves		99	4
Black pepper		1	0.1
Hot chilli pepper		5	0.1
Parsley		6	0.1
Water*		1092	-

**measured on only 4 observations*

Number of observations



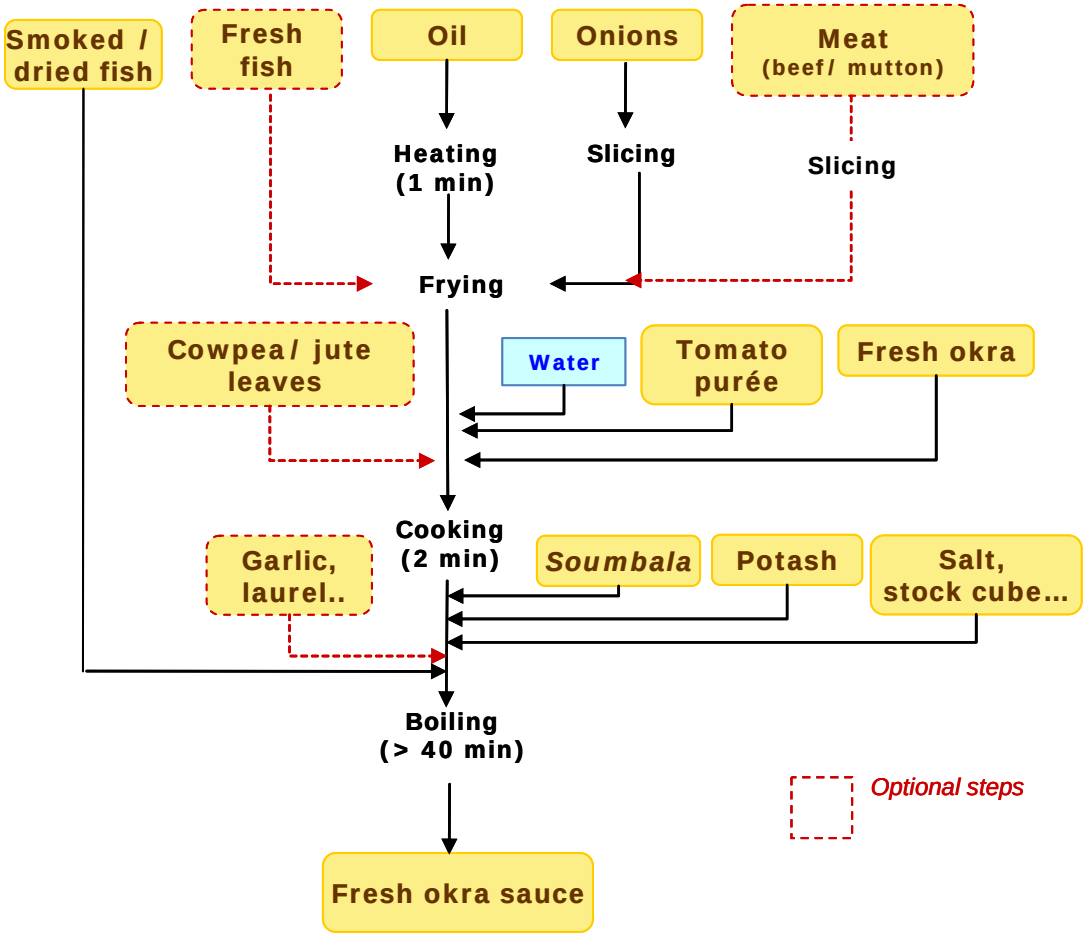
Fresh okra [1]

[1] photo of okra from the site:http://fr.wikipedia.org/wiki/Fichier:Bucket_of_raw_okra_pods.jpg

Recipe description

Heat up the oil in a pot before frying the onions.
If meat is available, roast it with the onions, if fish is used instead of meat, roast it separately. Add to everything the tomato purée, the water, the sliced fresh okra and the dried fish. Then add salt, stock cube, potash, fresh fish, crushed *soumbala* and garlic. Cook for about 40 min.

Process diagram



References

Seogo J (2008). Caractérisation des procédés de fabrication de plats traditionnels à base de maïs et sorgho et de leurs sauces. Bachelor report in food technology and nutrition, Lycée agro-environnemental Saint-Joseph du Breuil-sur-Couze / University of Auvergne.

Large roselle leaf sauce (1) - *Bito* sauce

Description and uses

Semi-liquid sauce usually used as a garnish of maize *tô* which is often consumed in urban areas.

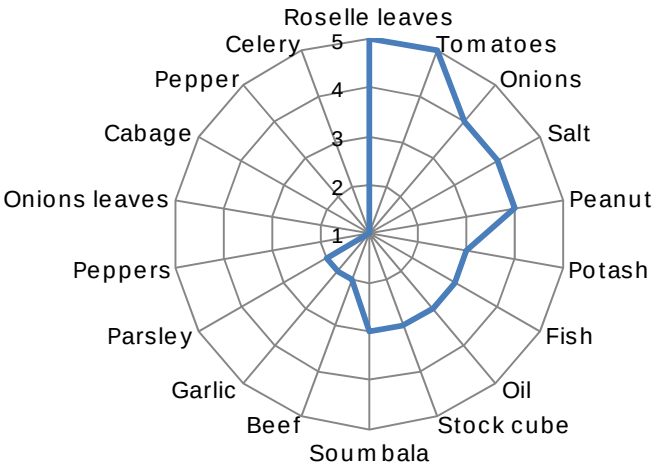
- **Date and place of observations**: 2008 and 2009 in Ouagadougou and Bobo Dioulasso.
- **Number of observations**: 5 observations in households.
- **Mean dry matter content** of the product as eaten: 17.9%.
- **Mean pH**: 5.4.

Ingredients

For 300 g of fresh leaves

Ingredients		Fresh weight (g)	%DM
Large Roselle leaves (*Bito*)		**300**	21
Tomato	Purée	31	2
	Fresh	126	3
Fresh onion		125	7
Salt		18	7
Groundnut paste		73	23
Potash		2	1
Fish	Smoked	15	3
	Fresh	146	3
Oil		45	10
Stock Cube		8	3
Soumbala		18	3
Beef meat		148	7
Garlic		15	2
Parsley		10	0.3
Pepper		45	1
Fresh onion leaves		55	1
Cabbage		106	1
Black pepper		31	2
Celery		2	<0.1
Water		1031	-

Number of observations

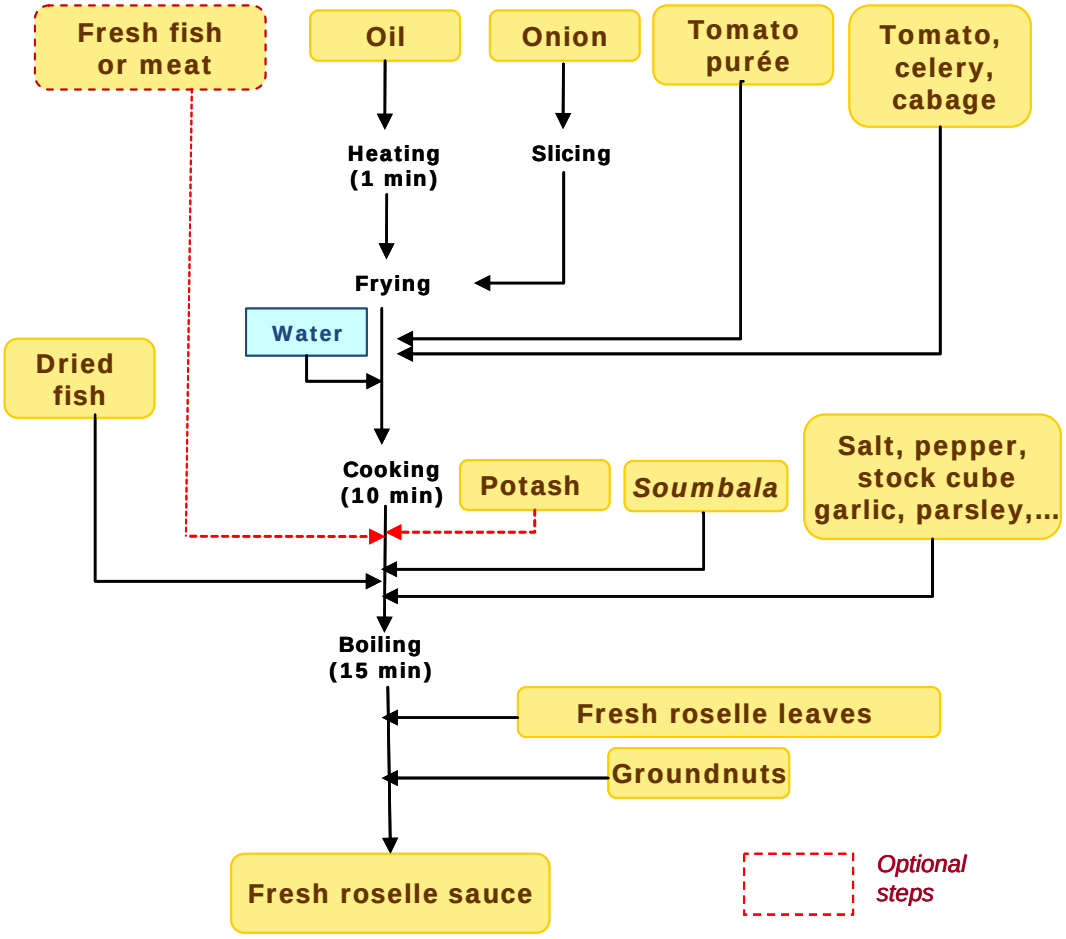


***Bito* leaves**

Recipe description

Heat up the oil in a pot before frying the onions with meat or fresh fish for a few minutes. Add the tomato purée, vegetables (tomato, cabbage, celery, pepper) and water and cook for 10 min. Then add dried fish, stock cube, potash and possibly fresh onion leaves, as well as black pepper, garlic, parsley and *soumbala* and cook for about 15 min.
Add fresh roselle leaves and groundnuts and cook for at least 15 minutes.

Process diagram



References

Rougerie J (2009). Identification, description et analyses des modes de préparation d'aliments constituant des sources potentielles en vitamine A dans l'alimentation des enfants de 6 à 35 mois au Burkina Faso. MSc report, Université Montpellier 2. 30p.

Seogo J (2008). Caractérisation des procédés de fabrication de plats traditionnels à base de maïs et sorgho et de leurs sauces. Bachelor report in food technology and nutrition, Lycée agro-environnemental Saint-Joseph du Breuil-sur-Couze / University of Auvergne.

Large roselle leaf sauce (2)

Maize tô with roselle sauce

Description and uses

Semi-liquid sauce made with fresh leaves of roselle. Generally used as a garnish of *tô* that is prepared from millet in this area.

- **Date and place of observations**: 2003, Province of Boulgou (Ouarégou) and 2009, Kokorowé.
- **Number of observations**: 7.
- **Mean dry matter content** of the product as eaten: 19.9%.
- **Mean pH**: 5.5

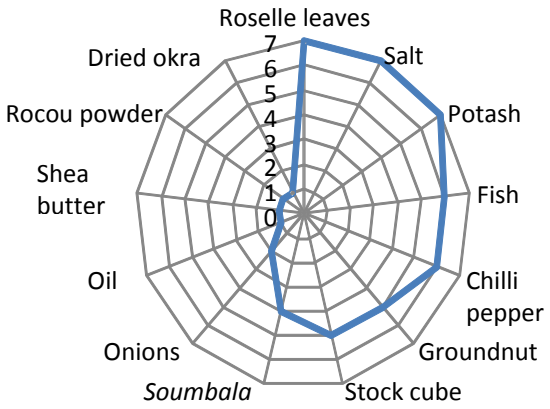
Ingredients

For 300 g of fresh leaves

Ingredients		Fresh weight (g)	%DM
Large roselle leaves		**300**	23
Salt		11	6
Potash	solid	18	4
	liquid	304	0,1
Smoked fish		14	5
Dried hot chilli		2	1
Groundnut paste		140	38
Stock cube		11	3
Soumbala		49	8
Fresh onion		151	1
Cotton oil		165	6
Shea butter		25	4
Rocou		10	0,4
Dried okra		5	1
Water*		896	-

**Measured on two observations*

Number of observations



Recipe description

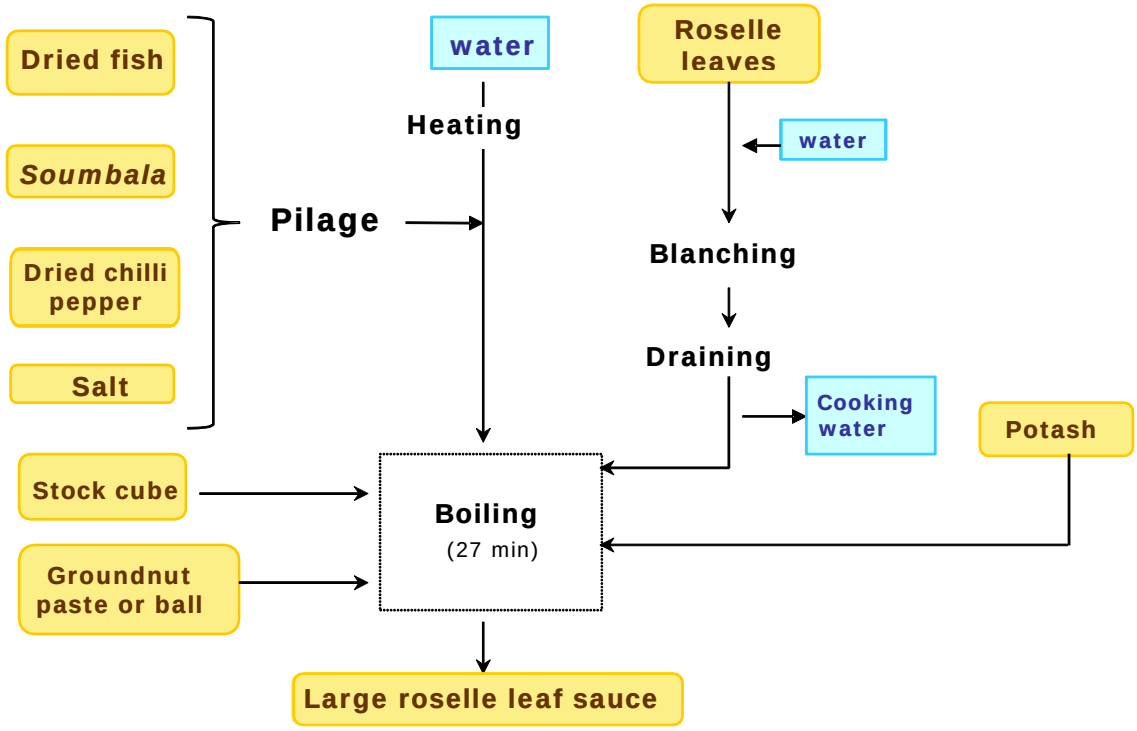
Roselle leaves are firstly blanched and drained. Then leaves are mixed with water and heated. Several ingredients (dried okra, dried fish, chilli pepper, *soumbala*, salt) are crushed with mortar and pestle and then added to the water and leaves. After a few

minutes, stock cube and ash extract are added. Everything is boiled for about 27 min in a cooking pot most often over a wood fire.

Frequency of observation of unit steps

Process stage	Number of observations (/7)
Blanching	7
Draining	7
Crushing	5
Addition of ash extract	5
Frying	1
Boiling	7

Process diagram



References

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Brault S (2003). Identification et description des modes de préparation des aliments constituent des sources potentielles en fer, zinc et vitamine A dans l'alimentation des enfants de 1 à 5 ans dans le village de Ouaregou au Burkina Faso. MSc report. University of Montpellier 2, France, 52 p.

Rougerie J (2009). Identification, description et analyses des modes de préparation d'aliments constituant des sources potentielles en vitamine A dans l'alimentation des enfants de 6 à 35 mois au Burkina Faso. MSc report, Université Montpellier 2. 30p.

Small roselle leaf sauce

Description and uses

Small roselle leaves

Semi-liquid sauce eaten at lunch or dinner with cereal-based dish. The plant used to prepare this sauce has not been clearly identified. It seems to be young leaves of *Hibiscus sabdariffa*. The small roselle leaves gives an acid taste to the sauce.

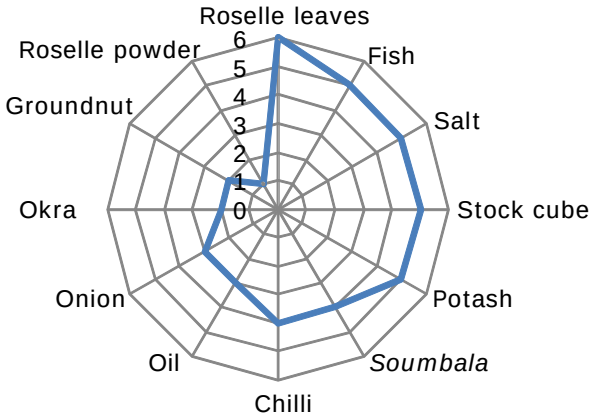
- Date and place of observations: 2003, Province of Boulgou (Ouarégou)
- Number of observations: 6
- Mean dry matter content of the product as eaten: 15.2%

Ingredients

For 300 g of fresh leaves

Ingredients		Fresh weight (g)	% DM
Small roselle leaves (*dâ*)		**300**	23
Dried fish		17	6
Salt		13	7
Stock cube		10	4
Potash	liquid	85	<0,1
	solid	22	3
Soumbala		21	9
Dried hot chilli		2	1
Groundnut oil		128	20
Fresh onion		101	2
Dried okra		39	6
Groundnut	paste	126	9
	ball	43	6
Fermented roselle powder		38	4

Number of observations



Recipe description

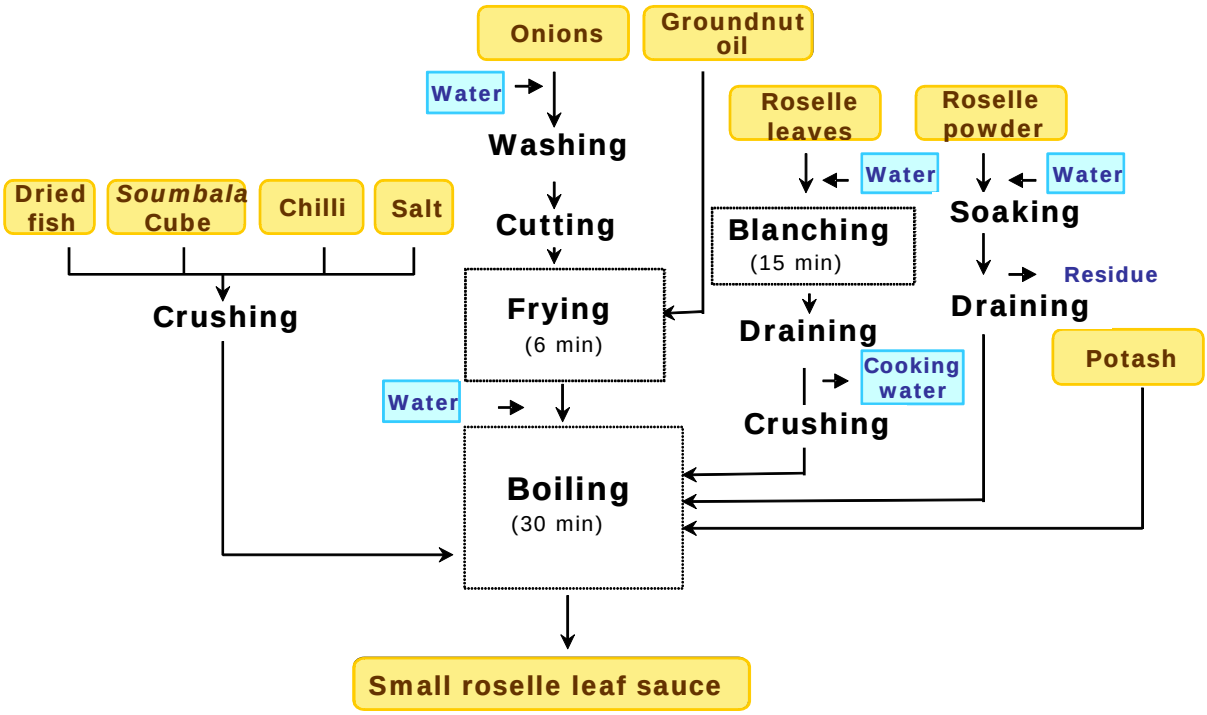
Onions are sliced and fried in groundnut oil; meanwhile roselle leaves are blanched during 11 min. After blanching, the acid water is discarded. Fried onions are put into water and crushed dried fish, *soumbala*, stock cube, salt and spices are added.

Fermented roselle powder is soaked in water and drained. The roselle extract resulting from this operation is added to the cooking sauce as well as potash or ash extract.
Boiling is carried on for 20 min into an aluminium cooking pot and most often over a wood fire.

Frequency of observation of unit steps

Process stage	Number of observations (/6)
Crushing	6
Blanching	6
Boiling	6
Addition of ash extract	6
Frying	3
Wet crushing	1
Soaking	1

Process diagram



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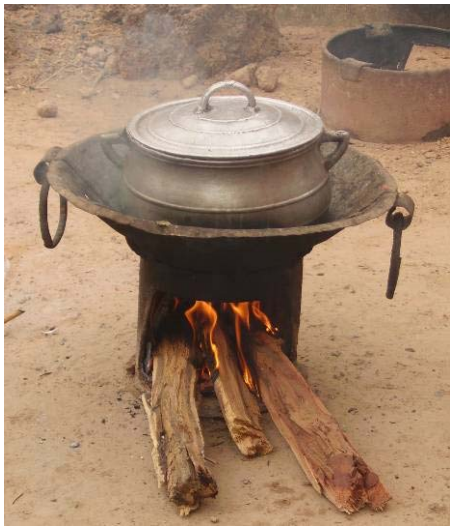
Avallone S, Tiemtore TWE, Mouquet-Rivier C, Trèche S (2008) Nutritional value of six multi-ingredient sauces from Burkina Faso. Journal of Food Composition and Analysis, 21, 7, 553-558.

Brault S (2003). Identification et description des modes de préparation des aliments constituent des sources potentielles en fer, zinc et vitamine A dans l'alimentation des enfants de 1 à 5 ans dans le village de Ouaregou au Burkina Faso. MSc report. University of Montpellier 2, France, 2 p.

Dried baobab leaf sauce - *Touega sauce*

Description and uses



Cooking of the sauce

This sauce was observed in rural area. This is a semi-liquid sauce eaten by the population with millet-based *tô* at lunch or dinner.

- **Date and place of observations**: 2003, Province of Boulgou (Ouarégou) and 2009 in Kokorowè.
- **Number of observations**: 7.
- **Mean dry matter content** of the product as eaten: 11.7%.
- **Mean pH**: 6.4.

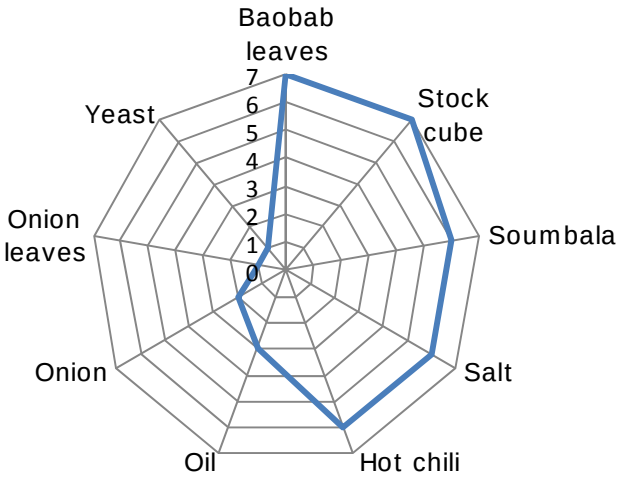
Ingredients

For 100 g of dried baobab leaves

Ingredients	Fresh weight (g)	%DM
Dried baobab leaves	**100**	39
Stock cube	28	11
Soumbala	71	20
Salt	25	10
Dried hot chilli	4	2
Groundnut oil	39	11
Fresh onion	53	2
Onion leaves	49	3
***Rabilé* (yeast)**	12	2
Water*	1452	-

**measured on only one observation*

Number of observations



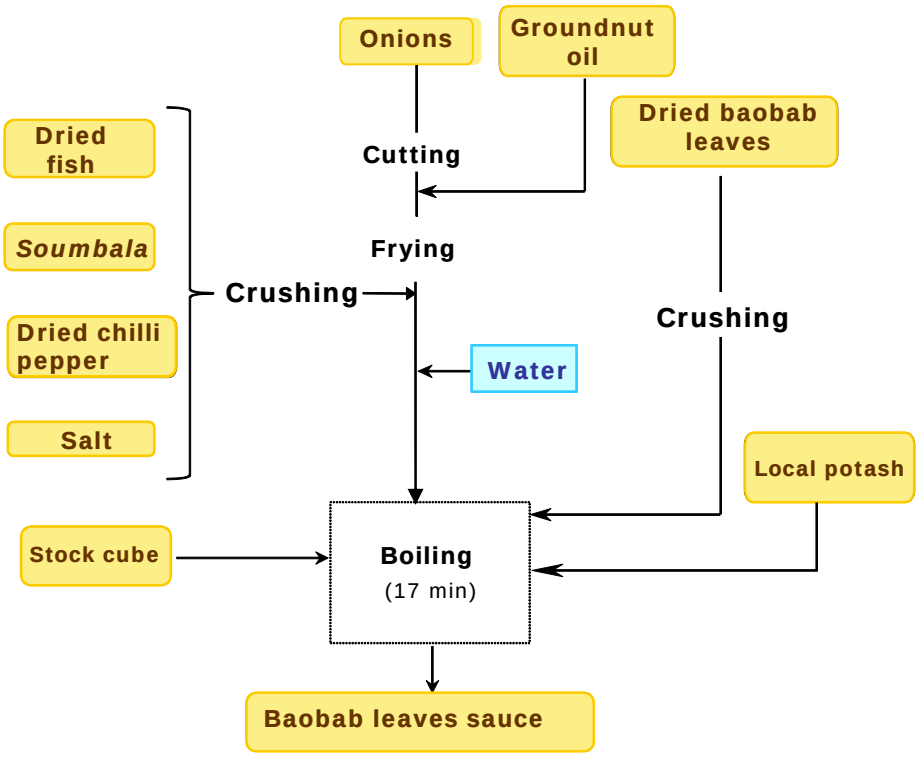
Recipe description

Several ingredients (dried fish, Chilli pepper, *soumbala*, salt) are crushed together with mortar and pestle and then added to hot water in a cooking pot. Dried baobab leaves are then crushed and added to the mix together with the stock cube. Cooking time is around 17 min.

Frequency of observations of the unit steps

Process stage	Number of observations (/7)
Crushing	7
Frying	3
Boiling	7

Process diagram



References

Avallone S, Tiemtore TWE, Mouquet-Rivier C, Trèche S (2008) Nutritional value of six multi-ingredient sauces from Burkina Faso. Journal of Food Composition and Analysis, 21, 7, 553-558.

Brault S (2003). Identification et description des modes de préparation des aliments constituant des sources potentielles de fer, zinc et de vitamine A dans l'alimentation des enfants de 1 à 5 ans dans le village de Ouarégou au Burkina Faso. MSc report. University of Montpellier 2, France.

Rougerie J (2009). Identification, description et analyses des modes de préparation d'aliments constituant des sources potentielles en vitamine A dans l'alimentation des enfants de 6 à 35 mois au Burkina Faso. MSc report, Université Montpellier 2. 30p.

Fresh baobab leaf sauce

Description and uses

Sauce made with fresh baobab leaves

This sauce is a variant of the previous one also observed in urban area. Made with fresh leaves, it is generally eaten with a cereal-based dish.

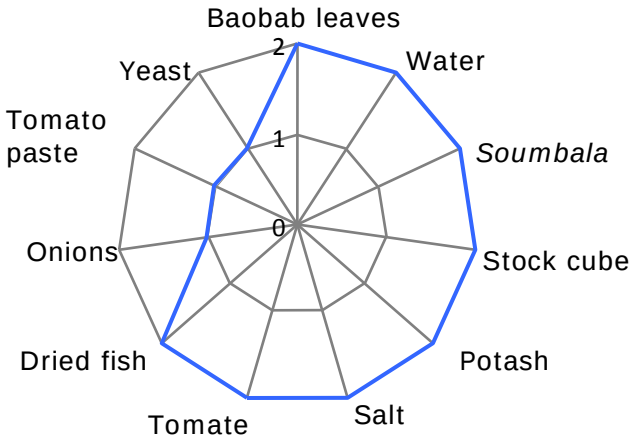
- **Date and place of observations**: 2008 in Ouagadougou.
- **Number of observations**: 2 observations in households.
- **Mean dry matter content** of the product as eaten: 9.1%.
- **Mean pH**: 7.2.

Ingredients

For 300 g of fresh leaves

Ingredients		Fresh weight (g)	% DM
Fresh baobab leaves		**300**	42
Soumbala		25	11
Stock cube		13	7
Potash (solid)		11	6
Salt		16	8
Tomato	purée	19	3
	fresh	50	2
Fish (dried, smoked)		29	13
Fresh onion		109	2
***Rabilé* (yeast)**		29	6
Water		2035	-

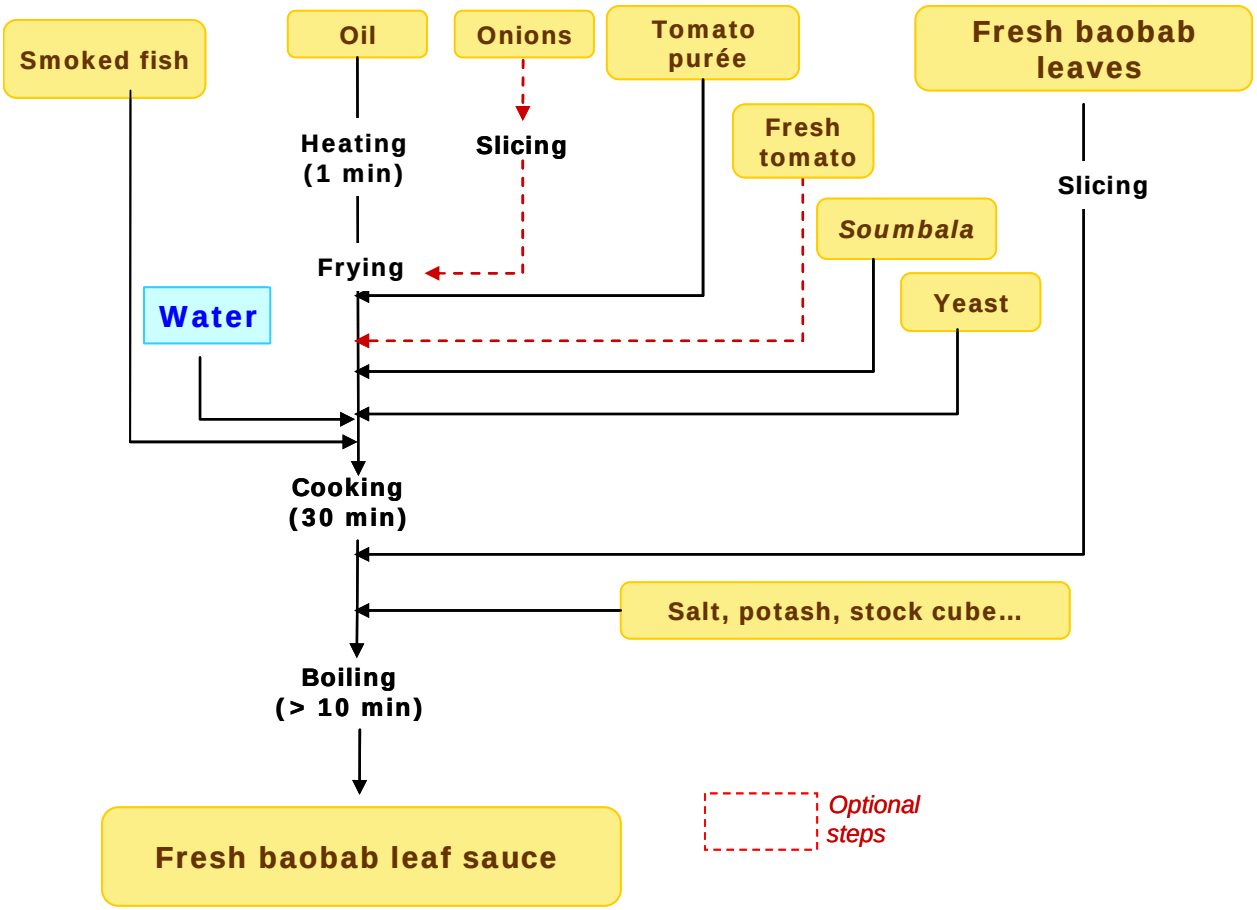
Number of observations



Recipe description

Heat up the tomato purée with crushed *soumbala* and possibly onions, yeast and fresh tomato.
Add dried fish and water and cook for about 30 min.
Then add baobab leaves and the other ingredients (salt, stock cube, potash).
Boil for at least 30min.

Process diagram



Fresh baobab leaves

References

Seogo J (2008). Caractérisation des procédés de fabrication de plats traditionnels à base de maïs et de manioc et de leurs sauces. Bachelor report in food technology and nutrition, Lycée agro-environnemental Saint-Joseph du Breuil-sur-Couze / University of Auvergne.

Baobab leaf powder sauce

Description and uses

Baobab leaf powder

The baobab leaf powder is available at the market. This powder is made with dried baobab leaves and used to prepare sauces.

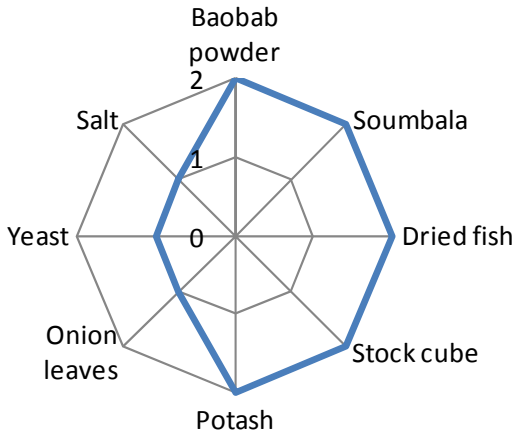
- **Date and place of observations**: 2008 in Ouagadougou.
- **Number of observations**: 2 observations in households.
- **Mean dry matter content** of the product as eaten: 11.0%.
- **pH:** 7.6

Ingredients

For 300 g of baobab leaf powder

Ingredients	Fresh weight (g)	% DM
Baobab powder	**300**	52
Soumbala	44	7
Dried fish	88	13
Stock cube	34	6
Local potash (solid)	21	3
Onion leaves	163	3
Yeast	209	13
Sel	50	3

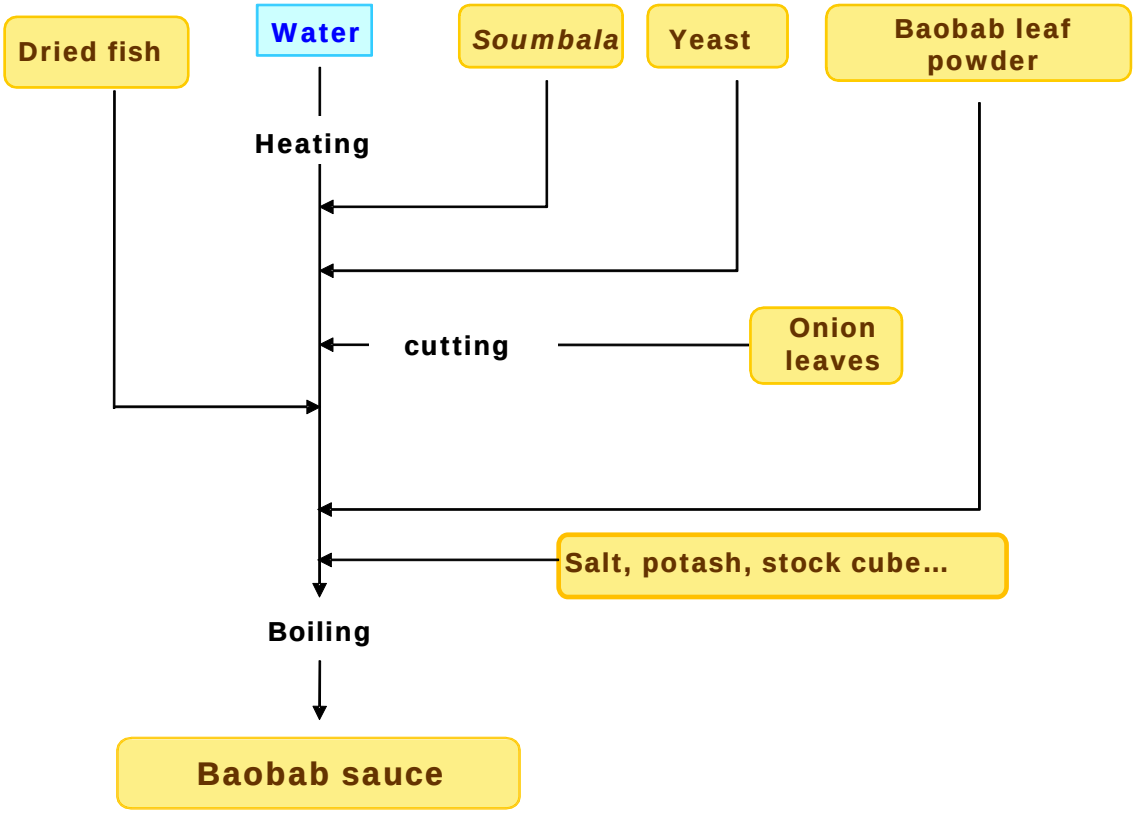
Number of observations



Recipe description

Soumbala, yeast (rabilé) dried fish and shopped onion leaves are put in a cooking pot containing hot water.
Then the baobab leaf powder is added, followed by other ingredients (stock cube, salt and local potash). The blend is cooked for several minutes.

Process diagram



References

Baille B (2008). Evaluation de la couverture des besoins en énergie, fer, zinc et vitamine A par l'alimentation chez les enfants de 1 à 5 ans en zone urbaine (Ouagadougou, Burkina Faso) et estimation de la participation des plats à base de mil, sorgho, maïs et manioc. MSc report, University of Montpellier 2, France. 77 p.

Cowpea leaf sauce - *Bengedo* sauce

Cowpea leaf sauce with white maize tô

Description and uses

Semi-liquid sauce often eat with the *tô* at lunch or dinner. The ingredients used in this sauce are very variables.

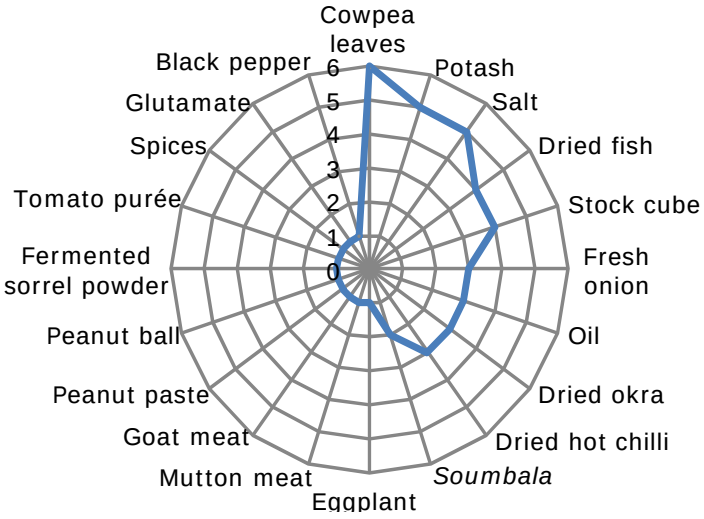
- **Date and place of observations**: 2003, Province of Boulgou (Ouarégou).
- **Number of observations**: 6.
- **Mean dry matter content** of the product as eaten**:** 17.0%.

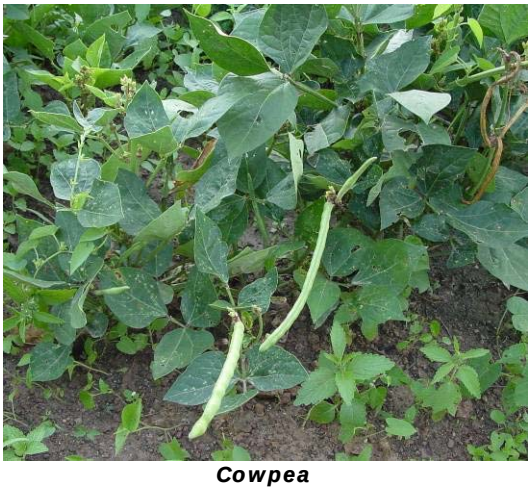
Ingredients

For 300 g of fresh leaves

Ingredients		Fresh weight (g)	% DM
Cowpea leaves		**300**	18
Potash	solid	10	1.2
	liquid	126	<0.1
Salt		16	5
Dried fish		38	8
Stock cube		17	9
Fresh onion		183	3
Peanut oil		142	19
Dried okra		26	4
Dried hot chilli pepper		3	0.5
Soumbala		49	5
Eggplant		352	2
Mutton meat		306	4
Goat meat		239	4
Groundnut paste		133	11
Groundnut ball		74	8
Fermented roselle powder		66	<0.01
Tomato purée		35	0.4
Spices		8	0.4
Glutamate		4	0.3
Black pepper		1	0.1

Number of observations





Cowpea

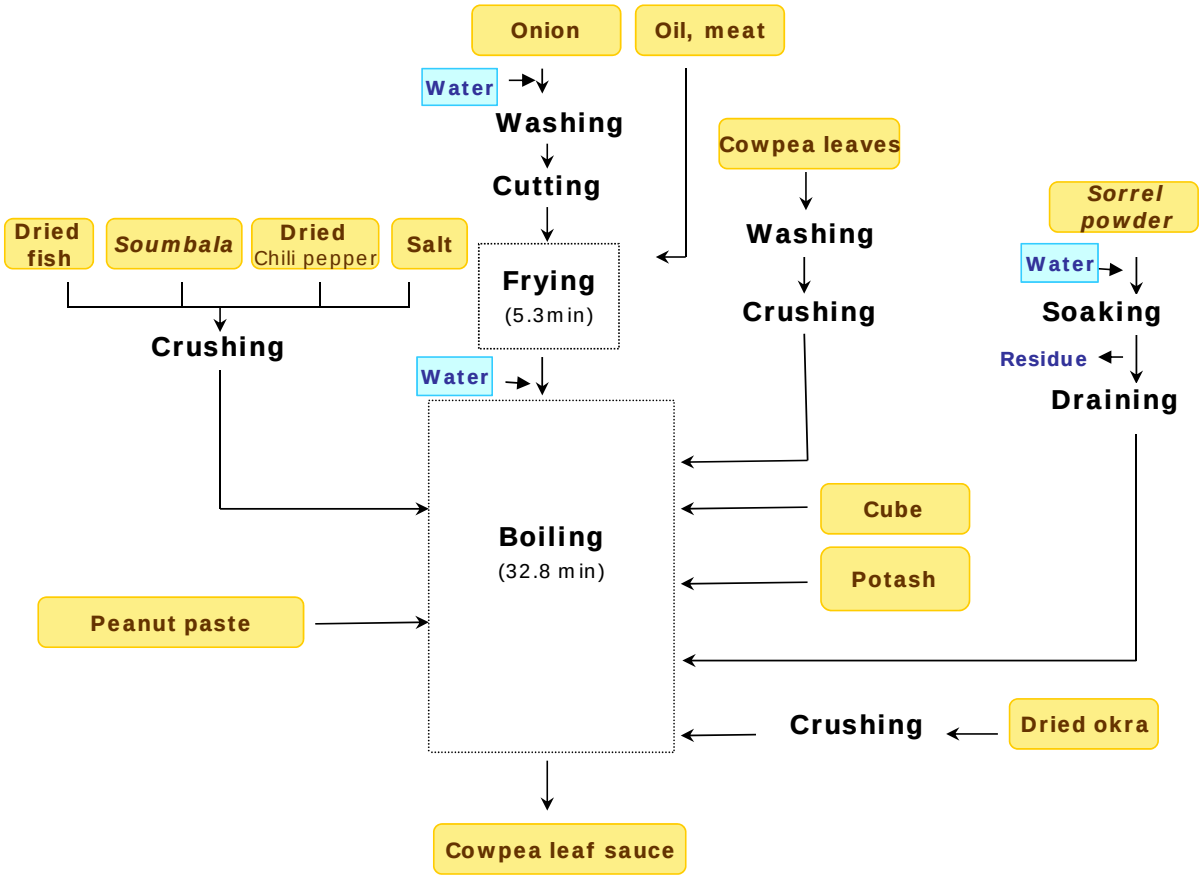
Recipe description

Cowpea leaves are crushed with a mortar and pestle before being added to fried onions. Then water is added. Dried fish, *soumbala*, salt and chilli pepper are crushed and mixed into the cooking pot with stock cube, ash extract (or potash), groundnut paste and sometimes dried okra. Water extract of fermented sorrel powder are sometimes added. Everything is cooked (boiling) for 33 min over a wood fire.

Frequency of observation of unit steps

Process stage	Number of observations (/6)
Washing of cowpea leaves	6
Crushing	6
Addition of ash extract or potash	6
Crushing of fresh leaves	3
Frying	3
Boiling	6

Process diagram



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Brault S (2003). Identification et description des modes de préparation des aliments constituant des sources potentielles de fer, zinc et de vitamine A dans l'alimentation des enfants de 1 à 5 ans dans le village de Ouarégou au Burkina Faso. MSc report. University of Montpellier 2, France.

Fresh jute leaf sauce- *Bulvaka* sauce

***Bulvaka* sauce**

Description and uses

Semi-liquid sauce prepared with leaves of *Corchorus olitorius*. Contrary to what is observed for many other leaves, jute leaves are rarely blanched.

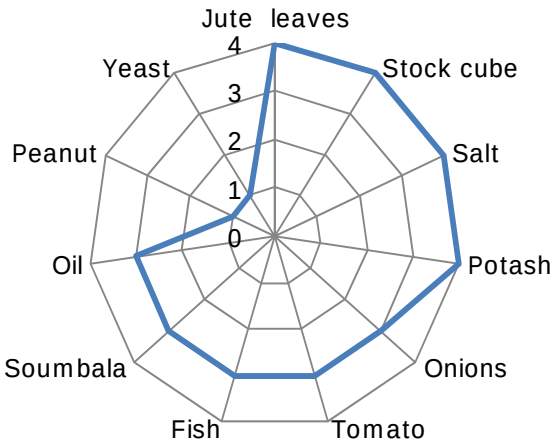
- **Date and place of observation**: 2009, Ouagadougou.
- **Number of observation**: 4.
- **Mean dry matter content**: 13.9%.
- **Mean pH**: 7.1.

Ingredients

For 300 g of leaves

Ingredients		Fresh weight (g)	% DM
Jute leaves *(bulvaka)*		**300**	18
Stock cube		22	10
Salt		9	4
Potash (solid)		9	5
Fresh onion		162	5
Tomato (fresh)		252	4
Fresh fish		115	4
Soumbala		46	15
Oil	red palm	102	20
	Groundnut	52	4
Groundnut paste		108	7
***Rabilé* (yeast)**		43	3
Water		1689	-

Nombre d'observations

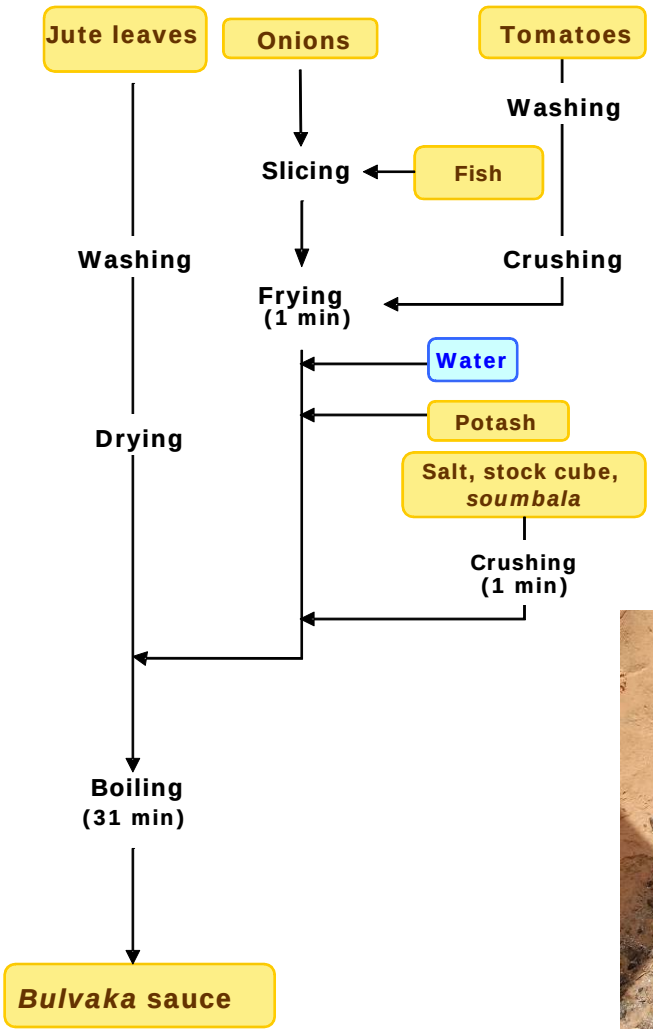


Ingredients for sauces

Recipe description

Jute leaves are first tailed, washed and dried. In only one observation, leaves were blanched and crushed with a sort of whisk made from dried stems (see photo).
Onions are then sliced and fried in oil with the fish.
Fresh tomatoes are crushed by hand or with a mortar and pestle before incorporation in the pot. Other ingredients such like potash, stock cube, yeast and crushed *soumbala* are incorporated after water addition.
Leaves are then added to this mix. When used, groundnut paste is added in last.
Everything is cooked to the boil for 31 min on average.

Process diagram



Crushing of leaves

Addition of jute leaves to the mix

References

Rougerie J (2009). Identification, description et analyses des modes de préparation d'aliments constituant des sources potentielles en vitamine A dans l'alimentation des enfants de 6 à 35 mois au Burkina Faso. MSc report, University of Montpellier 2, France. 30p.

Dried jute leaf sauce - *Bulvaka* sauce

Bulvaka sauce

Description and uses

This sauce is prepared with dried leaves.

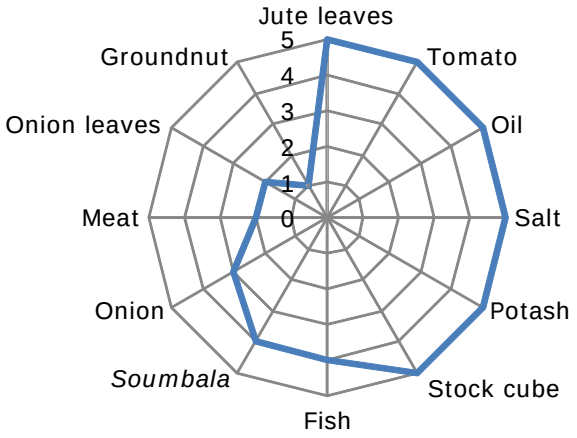
- **Date and place of observation**: 2009, Ouagadougou.
- **Number of observations**: 4.
- **Mean dry matter content**: 12.7%.
- **Mean pH**: 6.7.

Ingredients

For 100 g of dried leaves

Ingredients		Fresh weight (g)	% DM
Dried jute leaves		**100**	5
Tomato	fresh	350	6
	purée	38	2
Groundnut oil		81	28
Salt		21	8
Potash	solid	5	1
	liquid	17	0
Stock cube		18	7
Fish	fresh	119	2
	dried	36	6
Soumbala		42	8
Onion		109	3
Meat		255	13
Onion leaves		241	3
Groundnut paste		193	7
Water		2057	-

Number of observations

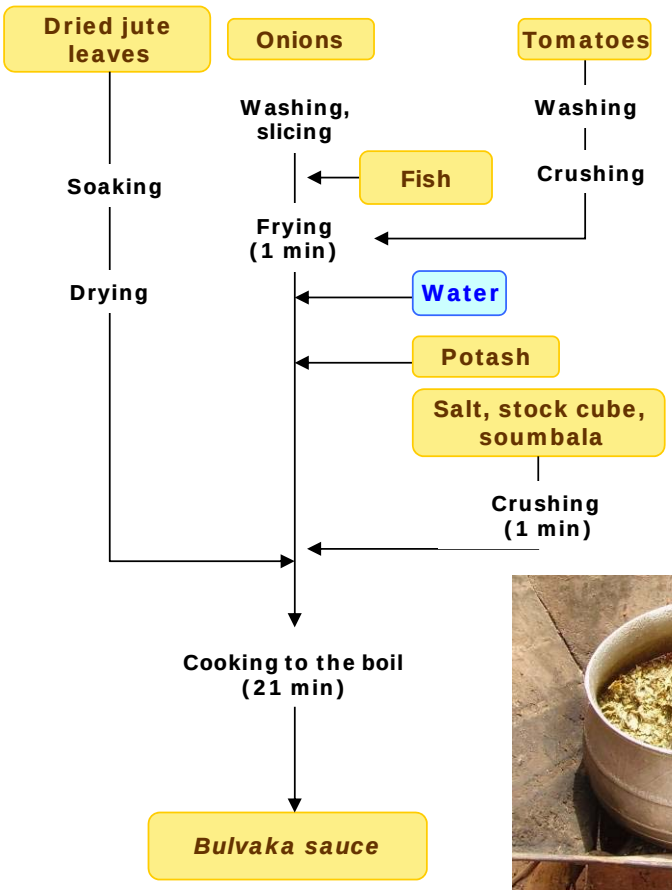


Dried jute leaves

Recipe description

Dried jute leaves are soaked in water to hydrate and wash them.
Sliced onions are then fried in hot oil.
Fresh tomatoes are crushed and mixed in the pot with fried onions and fish. The other ingredients as well as water are added to this mix. Leaves are then added to this mix. When used, groundnut paste is added last.
Everything is cooked to the boil for 21 min on average.

Process diagram



Addition of water

Mixing jute leaves to the preparation

References

Rougerie J (2009). Identification, description et analyses des modes de préparation d'aliments constituant des sources potentielles en vitamine A dans l'alimentation des enfants de 6 à 35 mois au Burkina Faso. MSc report, University of Montpellier 2, France. 30p

Cereal and leaf mix- *Babenda*

Description and uses

Babenda

This dish is prepared from amaranth and roselle leaves and also contains cereals like maize or rice, millet couscous or sorghum. It can be eaten as a sauce to accompany cereal-based dishes. Nevertheless, it is also eaten alone, with added stock cube and oil. In this case, it constitutes a complete dish that was usually eaten during the period between two harvests ("hunger gap") but it is becoming more and more popular in town and is sold in the street.

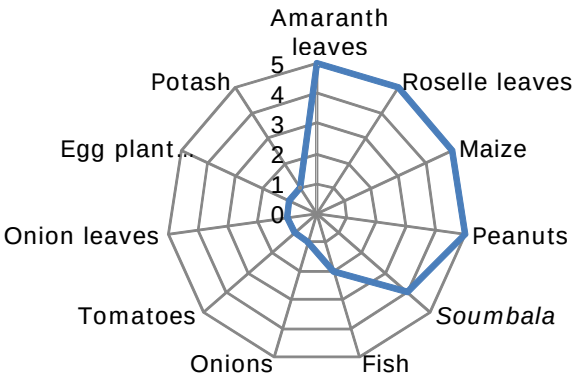
- **Date and place of observation**: 2009, Ouagadougou.
- **Number of observations**: 5.
- **Mean dry matter content** as eaten: 15.0%.
- **Mean pH**: 5.2.

Ingredients

For 300 g of fresh leaves

Ingredients		Fresh weight (g)	% DM
Amaranth leaves (*burum buri*)		**300**	22
Roselle leaves		299	22
Maize	Dehulled, ground	300	152
	Powder	226	29
Groundnuts		65	35
Soumbala		29	10
Dried fish		38	6
Onion		118	1
Tomato		206	2
Onion leaves		98	1
Ethiopian eggplant leaves		43	1
Potash (liquid)		22	0.04
Water		2202	-

Number of observations

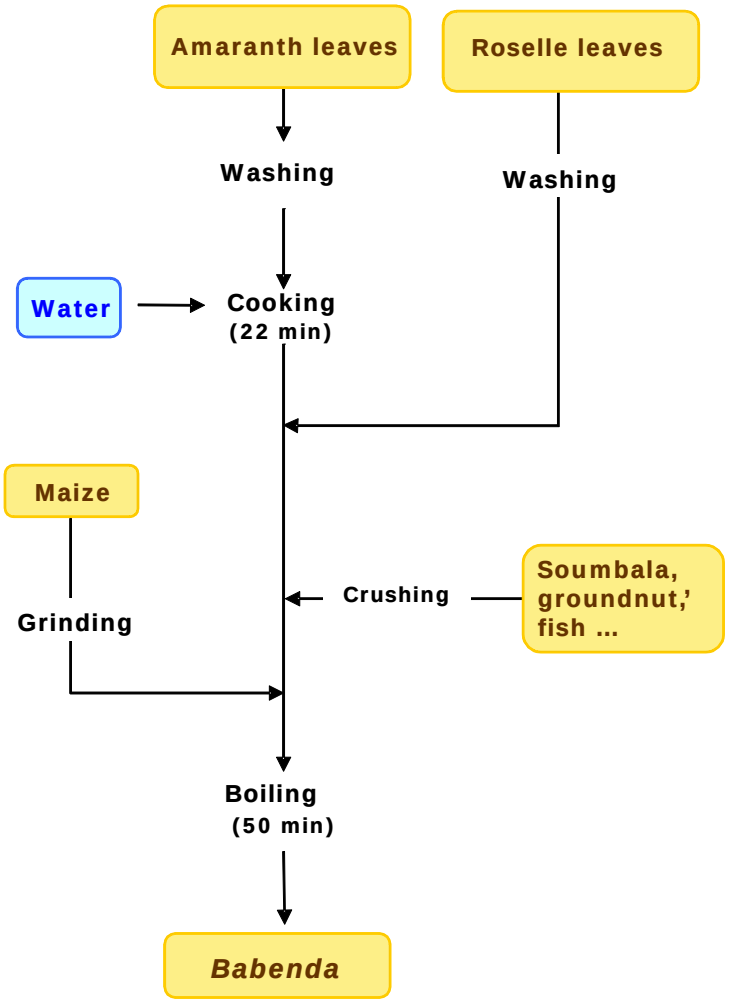


Amaranth leaves

Recipe description

Amaranth leaves are washed and blanched (potash is used only one time out of five). Roselle leaves are added few minutes later. During this time ingredients such like *soumbala*, groundnuts, fish, or tomatoes are crushed before adding to the pot.
Ground maize is added to this mix and the cooking is carried on for 50 min.

Process diagram



Ground maize added to the preparation

References

Rougerie J (2009). Identification, description et analyses des modes de préparation d'aliments constituant des sources potentielles en vitamine A dans l'alimentation des enfants de 6 à 35 mois au Burkina Faso. MSc report, University of Montpellier 2, France. 30p

Fresh *Cassia tora* leaf sauce - *Kirikiri* sauce

Description and uses

***Kirikiri* sauce**

This sauce is prepared with *Cassia tora* leaves.

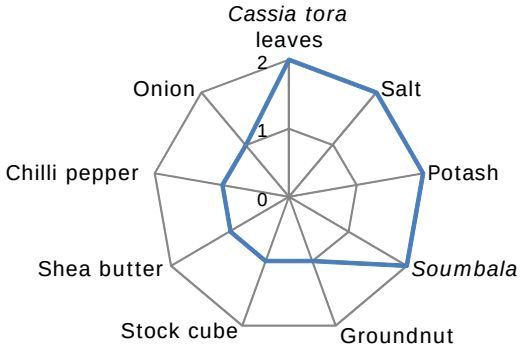
- **Date and place of observation**: 2009, Kokorowè.
- **Number of observations**: 2.
- **Mean dry matter content**: 15.5%.
- **Mean pH**: 7.4.

Ingredients

For 300 g of fresh leaves

Ingredients	Fresh weight (g)	% DM
***Cassia tora* leaves**	**300**	19
Salt	40	9
Potash (liquid)	2025	7
Soumbala	147	25
Groundnut	121	30
Stock cube	25	7
Shea butter	228	40
Dried chilli pepper	13	3
Onion	67	2
Water	2060	-

Number of observations

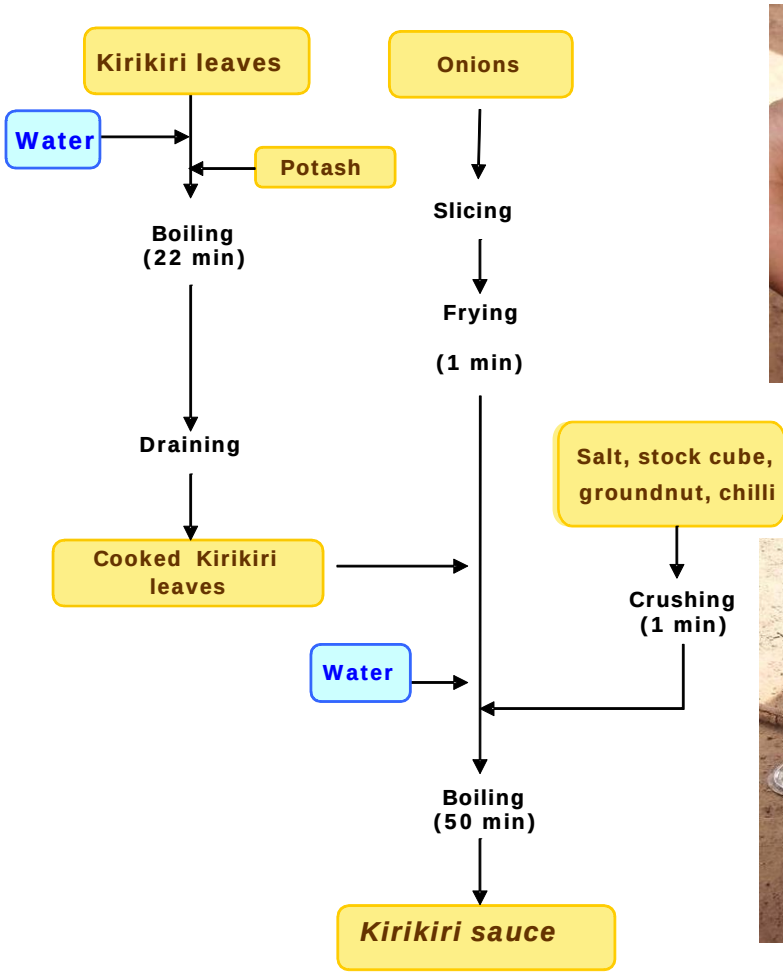


Ingredients for Kirikiri sauce

Recipe description

The leaves are first washed and then blanched for 22 min in water containing potash. When used, onions are first washed and sliced. Onions are then fried in a cooking pot containing hot oil. Water is added before the other ingredients such like chilli pepper, stock cube, groundnut and salt. Blanched and drained leaves are added to this preparation and everything is cooked for 50 min.

Process diagram



Young plants of Kirikiri

Material for Kirikiri sauce

References

Rougerie J (2009). Identification, description et analyses des modes de préparation d'aliments constituant des sources potentielles en vitamine A dans l'alimentation des enfants de 6 à 35 mois au Burkina Faso. MSc report, University of Montpellier 2, France. 30p

Dried *Cassia tora* leaf sauce - Sauce *Kirikiri*

Processing of Kirikiri sauce

Description and uses

Dried leaves are fisrt hydrated before use. Leaves are cooked with potash before addition to the other ingredients.

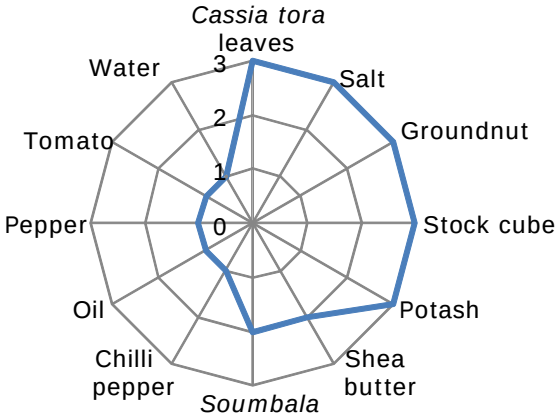
- **Date and place of observation**: 2009, Kokorowé.
- **Number of observations**: 3.
- **Mean dry matter content**: 23.6%.
- **pH of the sauce**: 7.5.

Ingredients

For 100 g of dried leaves

Ingredients		Fresh weight (g)	% DM
Dried *Cassia tora* leaves *(Kirikiri)*		**100**	47
Salt		4	2
Groundnut		84	28
Stock cube		9	4
Potash	Liquid	454	2
	Solid	0.4	0.1
Shea butter		87	10
Soumbala		25	2
Dried chilli pepper		2	0.2
Oil		28	4
Pepper		11	0.3
Tomato		23	0.4
Water		712	-

Number of observations

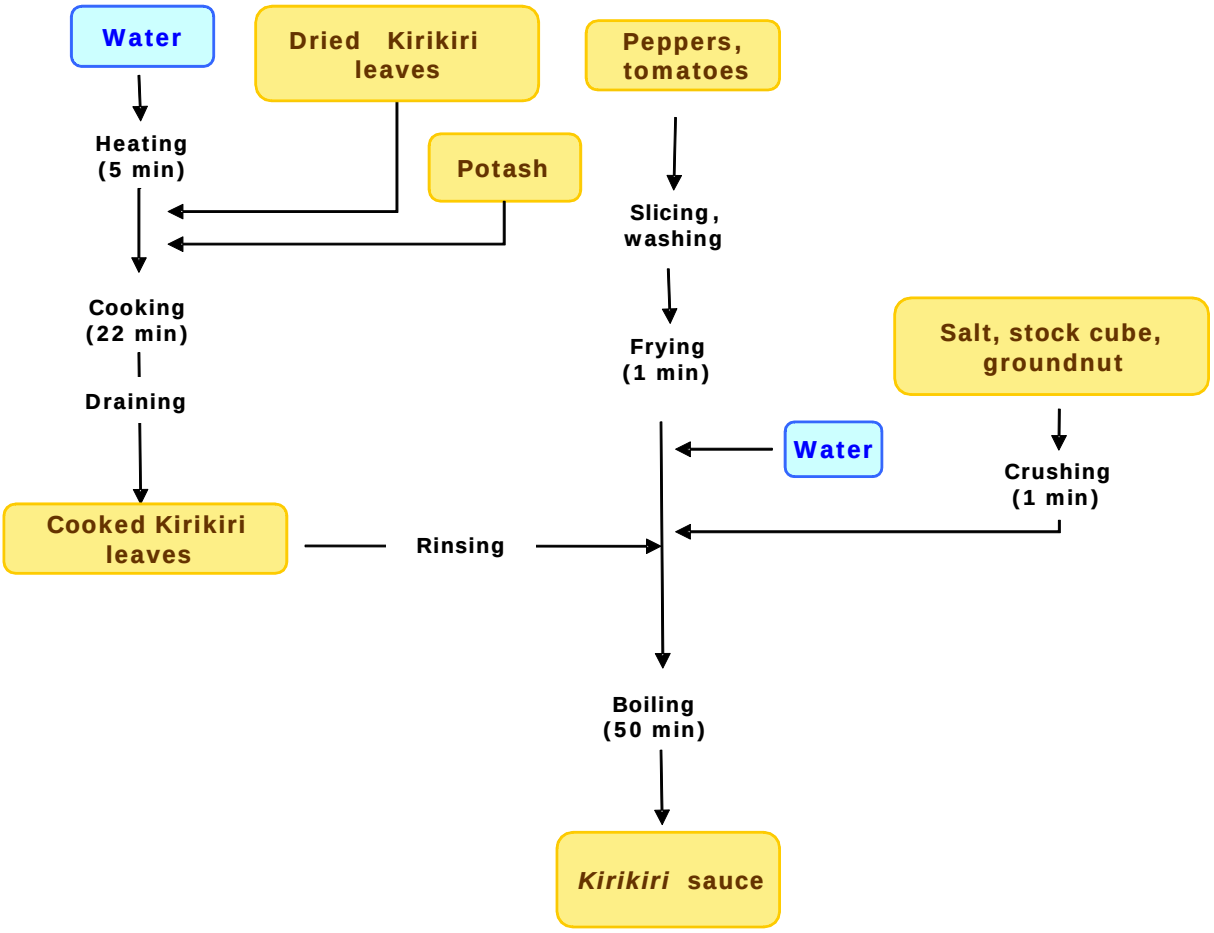


Dried Cassia tora leaves

Recipe description

Dried leaves are first hydrated in water and cooked in boiling water containing potash for 22 min. Then, leaves are drained and put aside. When used, peppers and tomatoes are first washed and sliced and fried in oil. Water is added to the cooking pot with salt and crushed groundnut, stock cube and *soumbala*
Cooked leaves are added to this preparation and everything is cooked for 50 min.

Process diagram



References

Rougerie J (2009). Identification, description et analyses des modes de préparation d'aliments constituant des sources potentielles en vitamine A dans l'alimentation des enfants de 6 à 35 mois au Burkina Faso. MSc report, University of Montpellier 2, France. 30p

Groundnut sauce

Description and uses

Semi-liquid sauce often eaten with rice at lunch or dinner. In this recipe, groundnut can be used as different forms: roasted groundnuts, oil, groundnut ball or paste. The ingredients used in these sauces are very variable. Leafy vegetables were only used in 4 groundnut sauces described in the study. The ingredient mean quantities were calculated for a total weight of ingredients of 1000 g.

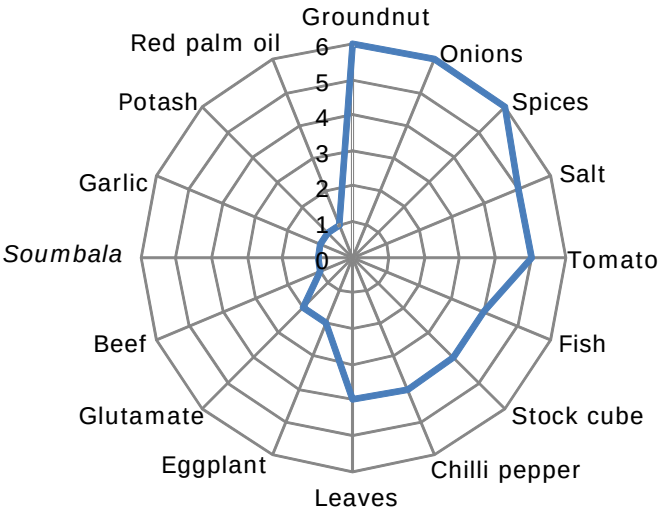
- **Date and place of observations**: 2003, Province of Boulgou (Ouarégou).
- **Number of observations**: 6.
- **Mean dry matter content** of the product as eaten: 18.7%.

Ingredients

For 1000 g of ingredients

Ingredients		Fresh weight (g)	%DM
Groundnut	ball	**109**	14
	paste	**112**	10
	roasted	**163**	9
	oil	**89**	25
Rocou (tomato powder)		16	3
Tomato paste		56	0.8
Fresh onions		126	2
Spices		5	2
Salt		16	6
Dried fish		33	14
Stock cube		6	2
Chilli pepper	dried	5	0.4
	fresh	5	0.0
***Cassia tora* leaves**		27	0.4
Onion leaves		48	0.7
Egg plant		78	2
Glutamate		4	0.4
Red palm oil		89	4
Beef		87	3
Soumbala		42	2
Garlic		1	0.0
Potash		5	0.3

Number of observations



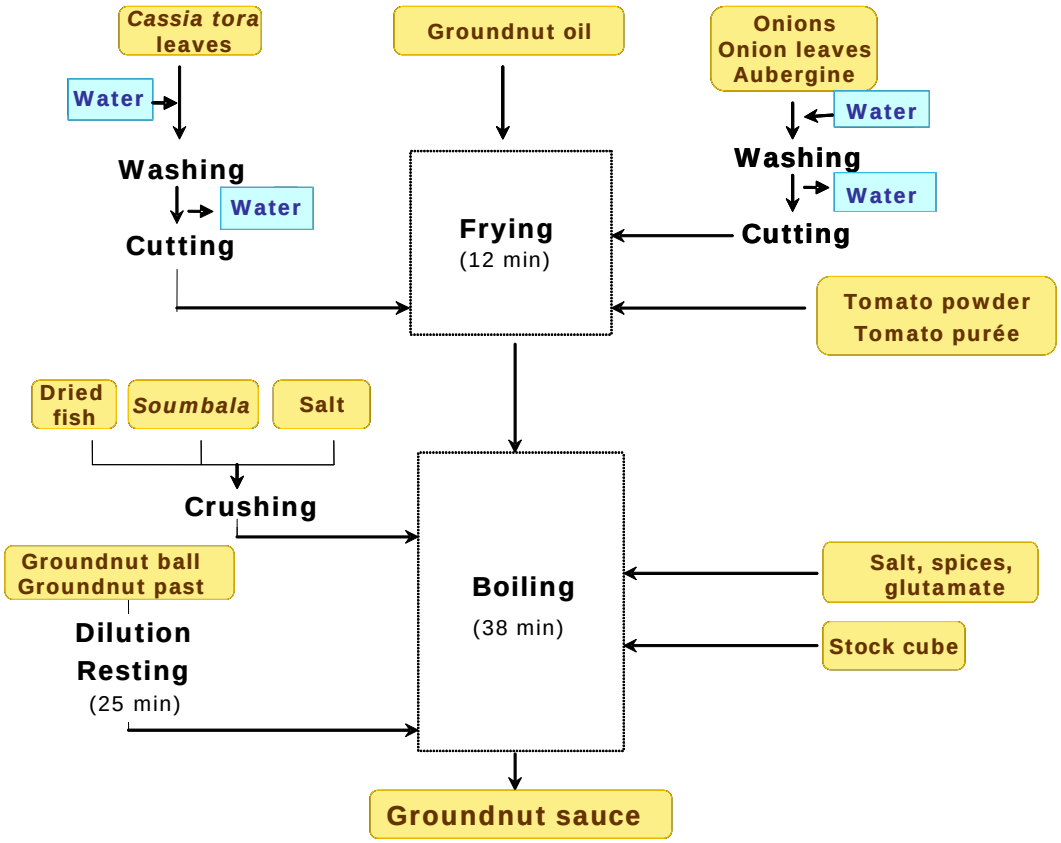
Frequency of observation of unit steps

Process stage	Number of observations (/6)
Washing fresh leaves	4
Frying	4
Crushing	3
Dilution	6
Resting	2
Addition of potash	1
Boiling	6

Recipe description

Onions are fried with groundnut oil and sliced onion leaves, aubergine, tomato powder and tomato purée. *Sokoto* leaves are washed, drained, sliced and added to the cooking pot together with water. *Soumbala,* dried fish and salt are crushed together and mixed with the other cooking ingredients.
Groundnut paste and/ or ball are diluted into water.
Salt, spices, glutamate and roasted groundnuts are also added. Everything is cooked for around 43.5 min.

Process diagram



References

Avallone S, Brault S, Mouquet C, Treche S (2007). Home-processing of the dishes constituting the main sources of micronutrients in the diet of preschool children in rural Burkina Faso. International Journal of Food Sciences and Nutrition, 58, 2, 108-115.

Avallone S, Tiemtore TWE, Mouquet-Rivier C, Trèche S (2008). Nutritional value of six multi-ingredient sauces from Burkina Faso. Journal of Food Composition and Analysis, 21, 7, 553-558.

Brault S (2003). Identification et description des modes de préparation des aliments constituent des sources potentielles en fer, zinc et vitamine A dans l'alimentation des enfants de 1 à 5 ans dans le village de Ouaregou au Burkina Faso. MSc report. University of Montpellier 2, France

Fish-tomato sauce

Description and uses

Sauce used to accompany the cereal-based dishes. It can be made with fresh and/or dried fish.

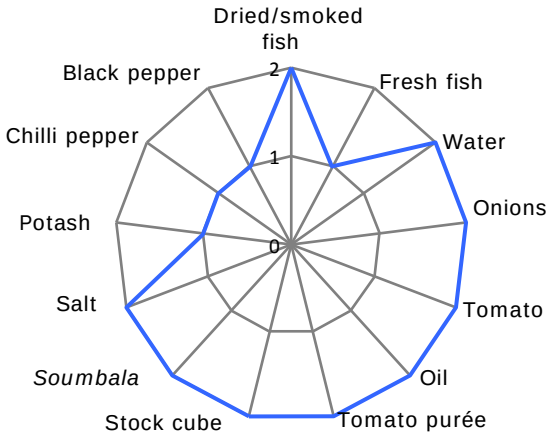
- **Date and place of observations**: 2008 in Ouagadougou.
- **Number of observations**: 2 observations in household.
- **Mean dry matter content** of the product as eaten: 9.4%.
- **Mean pH**: 6.0.

Ingredients

For 150 g of smoked or dried fish

Ingredients		Fresh weight (g)	% DM
Fish	dried	**150**	45
	fresh	**293**	19
Oil		40	13
Fresh onion		106	4
Tomato	purée	18	2
	fresh	74	1
Stock cube		8	3
Soumbala		14	4
Salt		10	3
Pepper		37	10
Potash		1	0.2
Chilli pepper		10	0.4
Water		1218	-

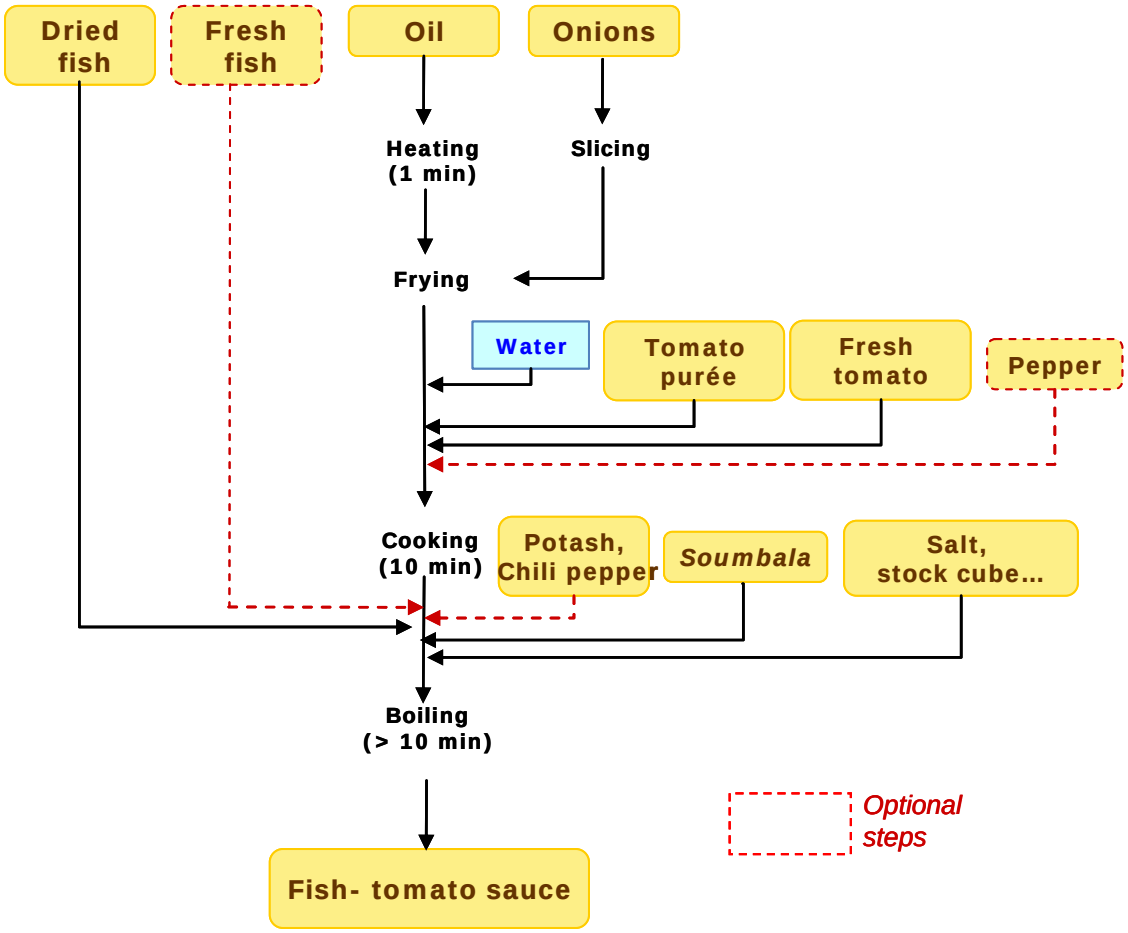
Number of observations



Recipe description

Heat up oil in a cooking pot, add onions and cook for 3 min.
Add tomato purée, fresh tomato, pepper and water and boil for few minutes.
Add fresh or dried fish and the other ingredients: salt, stock cube, *soumbala,* potash and chilli pepper.
Boil for at least 10 min.

Process diagram



Fish-tomato sauce

References

Seogo J (2008). Caractérisation des procédés de fabrication de plats traditionnels à base de maïs et sorgho et de leurs sauces. Bachelor report in food technology and nutrition, Lycée agro-environnemental Saint-Joseph du Breuil-sur-Couze / University of Auvergne.

Beef-tomato sauce

Description and uses

- **Date and place of observation**: 2008 in Ouagadougou.
- **Number of observation**: 1 observation.
- **Mean dry matter content** of the product as eaten: 13.8%.

Ingredients

For 300 g of meat

Ingredients	Fresh weight (g)	% DM
Beef	**300**	32
Fresh tomato	123	3
Cotton oil	105	44
Onion, shalot	79	4
Tomato purée	31	4
Stock cube	12	5
Salt	11	5
Potash	8	3
Hot Chilli pepper	1	0.5

References

Baille B (2008). Evaluation de la couverture des besoins en énergie, fer, zinc et vitamine A par l'alimentation chez les enfants de 1 à 5 ans en zone urbaine (Ouagadougou, Burkina Faso) et estimation de la participation des plats à base de mil, sorgho, maïs et manioc. MSc report, University of Montpellier 2, France. 77 p.

Mutton-tomato sauce

Description and uses

- **Date and place of observation**: 2008 in Ouagadougou.
- **Number of observation**: 1 observation.
- **Mean dry matter content** of the product as eaten: 13.8%.

Ingredients

For 300 g of meat

Ingredients		Fresh weight (g)	% DM
Mutton		**300**	61
Tomato	Purée	88	6
	Fresh	38	1
Courgette		165	9
Onion, shalot		109	7
Garlic		9	2
Salt		9	0.2
Stock cube		7	4
Parsley		3	4
Celery		2	0.1

References

Baille B (2008). Evaluation de la couverture des besoins en énergie, fer, zinc et vitamine A par l'alimentation chez les enfants de 1 à 5 ans en zone urbaine (Ouagadougou, Burkina Faso) et estimation de la participation des plats à base de mil, sorgho, maïs et manioc. MSc report, University of Montpellier 2, France. 77 p.

Kapok flower sauce - *Vouaga* sauce

Description and uses

- **Date and place of observations**: 2008 in Ouagadougou.
- **Number of observations**: 1 observation.
- **Mean dry matter content** of the product as eaten: 12.7%.

Ingredients

For 300 g of dried kapok kalyces

Ingredients	Fresh weight (g)	% DM
Dried kapok kalyces	**300**	27
Beef	815	20
Soumbala	200	16
Dried fish	148	11
Cotton oil	104	10
Tomato purée	92	2
Stock cube	80	7
Potash	72	0.2
Salt	56	5

References

Baille B (2008). Evaluation de la couverture des besoins en énergie, fer, zinc et vitamine A par l'alimentation chez les enfants de 1 à 5 ans en zone urbaine (Ouagadougou, Burkina Faso) et estimation de la participation des plats à base de mil, sorgho, maïs et manioc. MSc report, University of Montpellier 2, France. 77 p.

II- Recipes from Benin

II-A. Cereal-based dishes

Fermented maize dough - *Ogi*

Description and uses

Ogi is a dough used to prepare gruels (*koko*) and other dishes like *akassa* and *akpan*. The process differs from that of *mawè* at first because a pre-cooking step is added before milling and secondly, because grits and flour are not separated.

- **Date and place of observation**: 2009 in Cotonou.
- **Number of observations**: 5 observations in households.
- **Dry matter content**: 26.3%.

Ingredients

For 1000 g of maize

Ingredients		**Fresh weight** (g)	**% DM**
Maize		**1000**	100
Water	Pre-cooking	1510	-
	Soaking	1207	-
	Dough kneading	879	-
	Filtration	3946	-

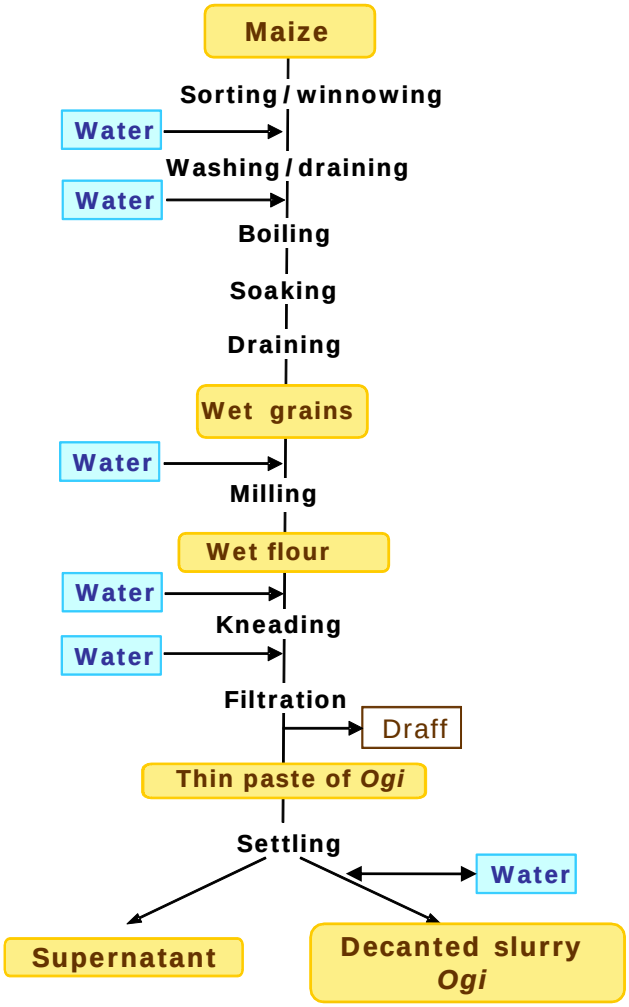
Recipe description

Ogi is mainly prepared with maize but sorghum or a mix of these two cereals can also be used.

Processing of ogi

- Grains are first soaked in water to remove the floating impurities. Sometimes cleaning is made by winnowing.
- Grains are then boiled for about 30min (between 15 and 50 min depending on the observations). Cooking is then stopped and the grains let stand in the water used for boiling for 8 to 43h (20h on average).
- The grains are washed in water and drained before milling in one unique step.
- Water is added to the milled grains to form a dough.
- Then the resulting dough is sieved by kneading on a metallic sieve or muslin with adding water. This stage allows the separation of starch and envelopes.
- The filtered flour is let in water for at least 24h. Fermentation occurs during this stage.
- The deposit is called o*gi*. It can be used after 24 to 48h of fermentation. To preserve *ogi* for several days, the supernatant is removed and fresh water is added.

Process diagram



Winnowing of grains

Sieving of dough

References

Gnimadi M (2009). Description des modes de préparation et caractérisation de plats traditionnels fréquemment consommés par les enfants de 6 mois à 3 ans au Bénin : effets des opérations unitaires sur les teneurs en minéraux et en phytates. MSc report. University of Montpellier 2, France. 31 p.

Hounhouigan DJ, Jansen JMM Nout MJR, Nago CM & Rombouts FM (1991). Production and quality of maize-based fermented dough in Benin urban area. IFS (International Foundation for Science), *Proceedings of a Regional Workshop on Traditional African Foods - Quality and Nutrition*, 25-29 Nov. 1991, Editors A Westby and PJA Reilly. pp. 8-18.

Lambert C (1997). Les bouillies à base de céréales fermentées utilisées pour l'alimentation des jeunes enfants en zones urbaines et périurbaines au Bénin : identification, caractérisation et procédés de fabrication. Mémoire de DESS, Nutrition et Alimentation dans les pays en développement. University of Montpellier 2, France.

Nago CM, Hounhouigan DJ (1998). La transformation alimentaire traditionnelle des céréales au Bénin . Les publications du CERNA N°1. Centre Régional de Nutrition et d'Alimentation Appliquées – FSA/UNB.

Ogi gruel - *Koko*

Description and uses

This gruel is made from fermented-maize dough named *ogi*. *Koko* is often eaten by children for breakfast but also as a snack with added roasted groundnuts or cake. This gruel is often sold in the street by peddler saleswomen. *Koko* have a homogeneous texture and constitutes the most frequently eaten gruel for children.

- **Date and place of observation**: 1997 in Cotonou and surrounding area.
- **Number of observations**: 11 observations in traditional transformation units.
- **Dry matter content** of the dish as eaten: 7.9% for not-sweetened *koko* and 13.1% for sweetened *koko*.

Ingredients

For 1000 g of Ogi paste

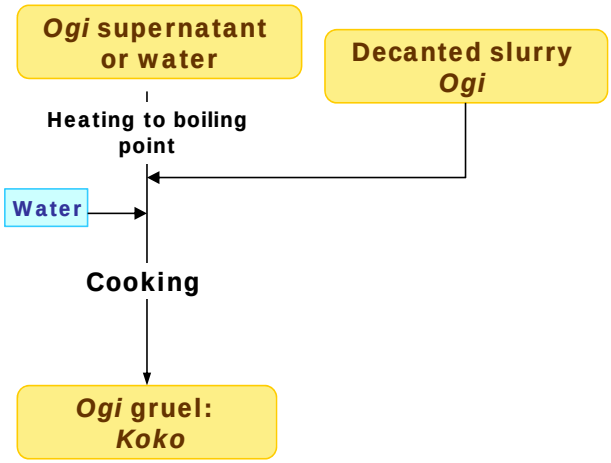
Ingredients	Fresh weight (g)	% DM
***Ogi* paste**	**1000**	100
Water*	4000	-

**estimate*

Recipe description

- 3.5L to 4L of water or *ogi* supernatant are brought to the boil in a cooking pot.
- Pieces of *ogi* are diluted in supernatant or 500 mL water and poured in the cooking pot containing boiling water.
- The gruel is cooked for 10 min on average.

Process diagram



References

Lambert C (1997). Les bouillies à base de céréales fermentées utilisées pour l'alimentation des jeunes enfants en zones urbaines et périurbaines au Bénin : identification, caractérisation et procédés de fabrication. Mémoire de DESS, Nutrition et Alimentation dans les pays en développement. University of Montpellier 2, France.

Fermented maize dough - *Mawè*

Description and uses

This fermented dough is made from maize and used to prepare several dishes such like a*kassa, akpan*, *aklui*, *koko*, *talé-talé*, etc. The process includes a step to separate grits from flour which are processed separately before being mixed again at the end of the recipe. This paste is often sold in the street by peddler saleswomen.

- **Date and place of observation**: 2009 in Cotonou.
- **Number of observations**: 5 observations in traditional transformation units.
- **Dry matter content** of the dish as eaten as prepared: 49.5%.
- **pH**: 5.8.

Ingredients

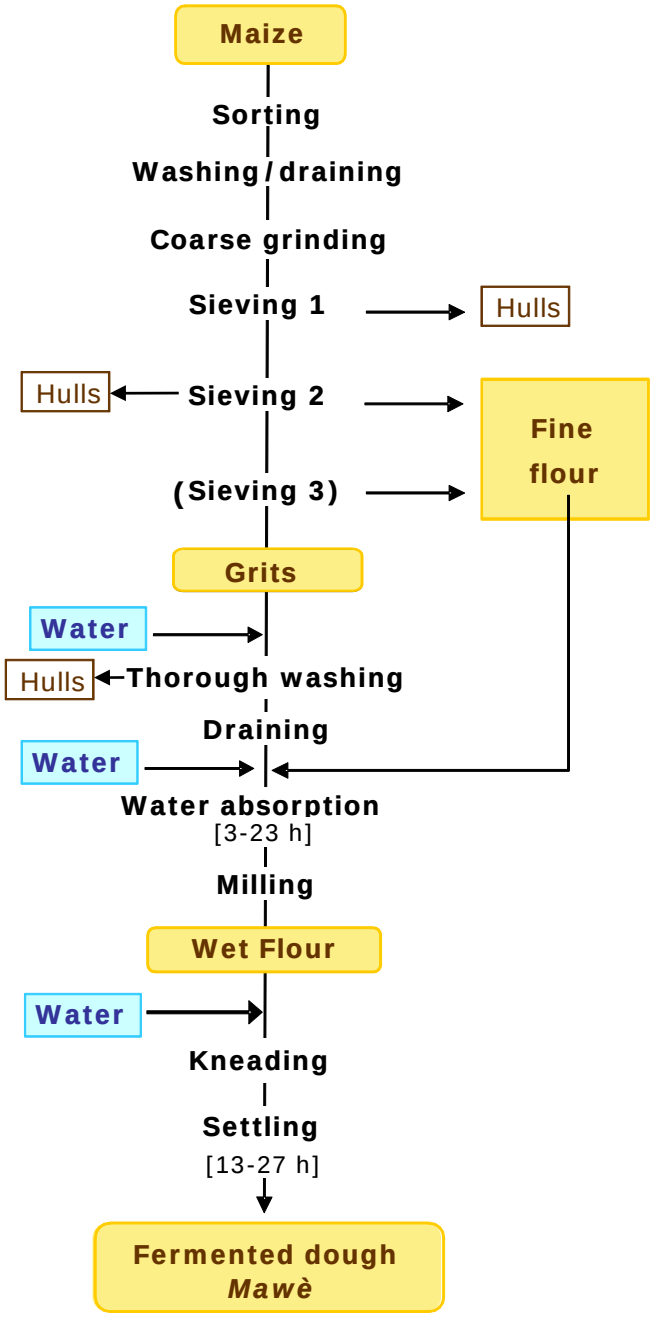
For 1000 g of maize

Ingredients		**Fresh weight** (g)
Maize	Raw grains	**1000**
	Enveloppes	178
	Flour	487
	Grits	446
	Fermented dough	1116
Water added before the water absorption step		446
Water added for kneading		185

Recipe description

- First, cleaning of grains is made by sorting and winnowing. Then grains are washed by soaking in water and the floating impurities are removed.
- Grains are then crushed in a mill.
- The following sieving stage aims at separating the hulls and flour form grits. First sieving is often made on a large wicker sieve to separate hulls from the other parts of the grain. A second (and sometimes a third) sieving (smaller sieve size) is made to separate grits and flour.
- Grits are then poured in water and vigorously rubbed. Impurities floating in water are removed with a sieve. This stage can be done several times.
- Flour is then blended with grits before or after the water absorption stage that lasts for between 3 and 23 hours.
- A second milling is then realised on the same mill as previously.
- After milling, the women gradually formed dough by mixing flour with water and kneading until they obtain a homogeneous dense product. This dough stand for several hours (often 24h) during which fermentation occurs.

Process diagram



Maize grain sorting

Sieving of grits

Flour obtained after the second milling

References

Gnimadi M (2009). Description des modes de préparation et caractérisation de plats traditionnels fréquemment consommés par les enfants de 6 mois à 3 ans au Bénin : effets des opérations unitaires sur les teneurs en minéraux et en phytates. MSc report. University of Montpellier 2, France. 31 p.

Hounhouigan DJ, Jansen JMM Nout MJR, Nago CM et Rombouts FM (1991). Production and quality of maize-based fermented dough in Benin urban area. IFS (International Foundation for Science), *Proceedings of a Regional Workshop on Traditional African Foods - Quality and Nutrition*, 25-29 Nov. 1991, Editors A Westby and PJA Reilly. pp. 8-18.

Mawè gruel - *Aklui*

Description and uses

Aklui

This granular gruel is made from *mawè*. Owing to its granular consistency, this gruel is less often eaten by children but it is still appreciated by the population for breakfast or any other meal during the day. This gruel is often sold in the street by peddler saleswomen but occasionally, mothers buy the intermediary product (*mawè*) and prepare the gruel at home.

- **Date and place of observation**: 2009 in Cotonou.
- **Number of observations**: 5 observations in households.
- **Dry matter content** of the dish as eaten: 7.5%.
- **pH**: 4.7.

Ingredients

For 1000 g of maize

Ingredients	**Fresh weight** (g)
Raw maize grains	**1000**
Mawè dough	1116
Water for cooking	7750
Lemongrass leaves	qs
Final gruel - *Aklui*	6655

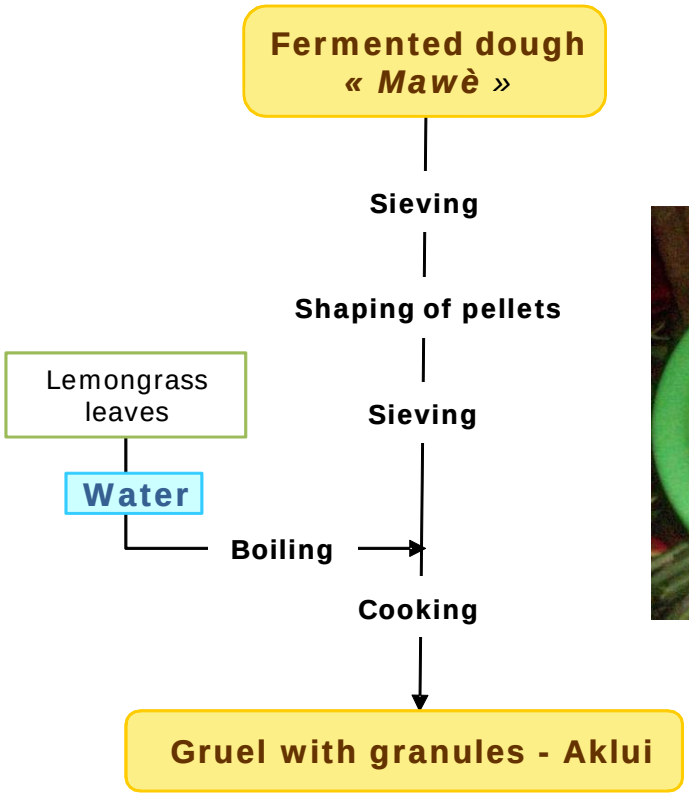
Recipe description

- Water, sometimes flavoured with lemongrass, is brought to the boil in a cooking pot.
- Meanwhile, women take pieces of dough (*mawè*) and sieve them trough a wicker sieve (size 2 mm) in order to shape small pellets of dough.
- The pellets are then rolled up by circular movements of the bowl.
- Then, pellets are firmed up by manual rolling and sieved with a *sassado*[1] to homogenate the size.
- These pellets are poured in boiling water and cooked for 10-15 min.

[1] *A sassado is a plant-based hand-crafted sieve fabricated to sieve maize grits.*

Sugar is generally added before eating. Aklui is consumed with roasted groundnuts or cakes

Process diagram



Shaping of pellets

References

Gnimadi M (2009). Description des modes de préparation et caractérisation de plats traditionnels fréquemment consommés par les enfants de 6 mois à 3 ans au Bénin : effets des opérations unitaires sur les teneurs en minéraux et en phytates. MSc report. University of Montpellier 2, France. 31 p.

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Fermented maize gruel - *Gbangba*

Description and uses

"Gbangba" gruel is made from crushed and fermented maize. During this process, there is neither pre-cooking step (used for making *ogi*) nor separation between grits and flour (used for making *mawè*). Nevertheless, the supernatant obtained from *ogi* is sometimes used to cook the gruel.

- **Date and place of observation**: 2009 in Cotonou.
- **Number of observations**: 2 observations in households.
- **Dry matter content** of the dish as eaten: 12.3%.
- **pH**: not determined.

Ingredients

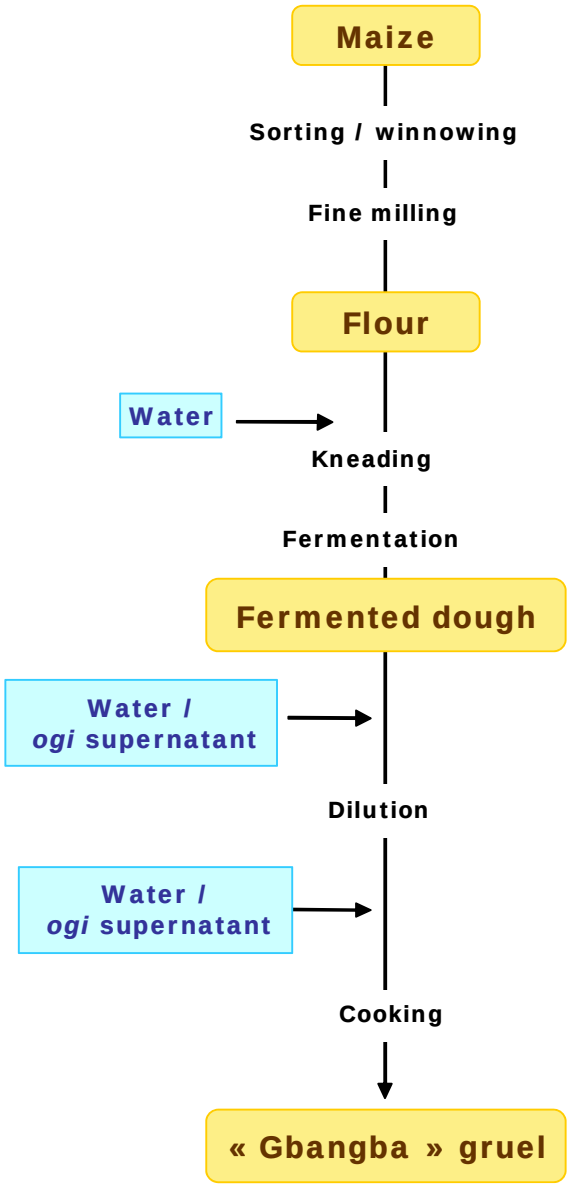
For 1000 g of maize

Ingredients	Fresh weight (g)	% DM
Maize (raw grains)	**1000**	100
Flour	849	
Fermented dough	1854	
Water for cooking (or *ogi* supernatant)	5902	--

Recipe description

- Grains are cleaned by winnowing or manual sorting and milled.
- Part of the flour obtained is mixed with water and kneaded. Then the dough is let stand for 16 to 20h during while fermentation occurs.
- Fermented dough is diluted in water or *ogi* supernatant.
- Water or *ogi* supernatant is brought to the boil in a pot. The dough is poured and cooked for 9 to 23 min and regularly mixed.

Process diagram



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Maize-based fermented dough - *Akassa*

Description and uses

Akassa balls

Akassa is a fermented dough obtained from *ogi* or *mawè* (previously described). It is a very popular dish in Benin, for young children as well as adults.
This dough is often presented wrapped in leaves (leaves from teck, banana tree or from *Thalia*). It is generally eaten with a sauce.

- **Date and place of observation**: 2009 in Cotonou.
- **Number of observations**: 5 observations in households.
- **Dry matter content** of the dish as eaten: 14.7%.
- **pH**: 4.7.

Ingredients

For 1000 g of Mawè or Ogi

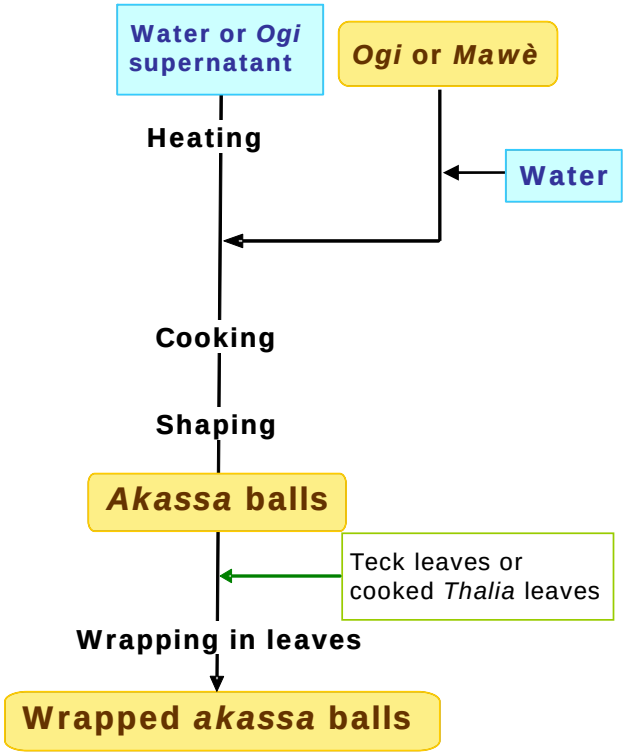
Ingredients	Fresh weight (g)
Mawè* or *Ogi	**1000**
Supernatant and/or water	2000

Recipe description

Akassa is cooked from *mawè* or *ogi.* Processing takes from 30 to 40 min.

- Approximately 2 kg of water or supernatant from *ogi* is brought to the boil in a cooking pot.
- About 1 kg of *mawé* or *ogi* diluted is fresh water is then added to the cooking pot and thoroughly mixed to obtain a fluid suspension. Everything is cooked for 5 to 10 min.
- Cooked dough is then shaped in small balls that are wrapped in leaves.
- *Akassa* is eaten with a fish- or meat- based sauce.

Process diagram



Mixing of dough

Dough wrapped in teck leaves

References

Gnimadi M (2009). Description des modes de préparation et caractérisation de plats traditionnels fréquemment consommés par les enfants de 6 mois à 3 ans au Bénin : effets des opérations unitaires sur les teneurs en minéraux et en phytates. MSc report. University of Montpellier 2, France. 31 p.

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Cooked maize paste - *Owo*

Description and uses

Cooking of Owo

Owo is a not-fermented paste obtained by single milling of whole maize grains followed by cooking in water. This is a staple dish that is usually eaten with a sauce.

- **Date and place of observation**: 2009 in Cotonou.
- **Number of observations**: 5 observations in houshold.
- **Dry matter content** of the dish as eaten: 20.3%.
- **pH**: 6.2.

Ingredients

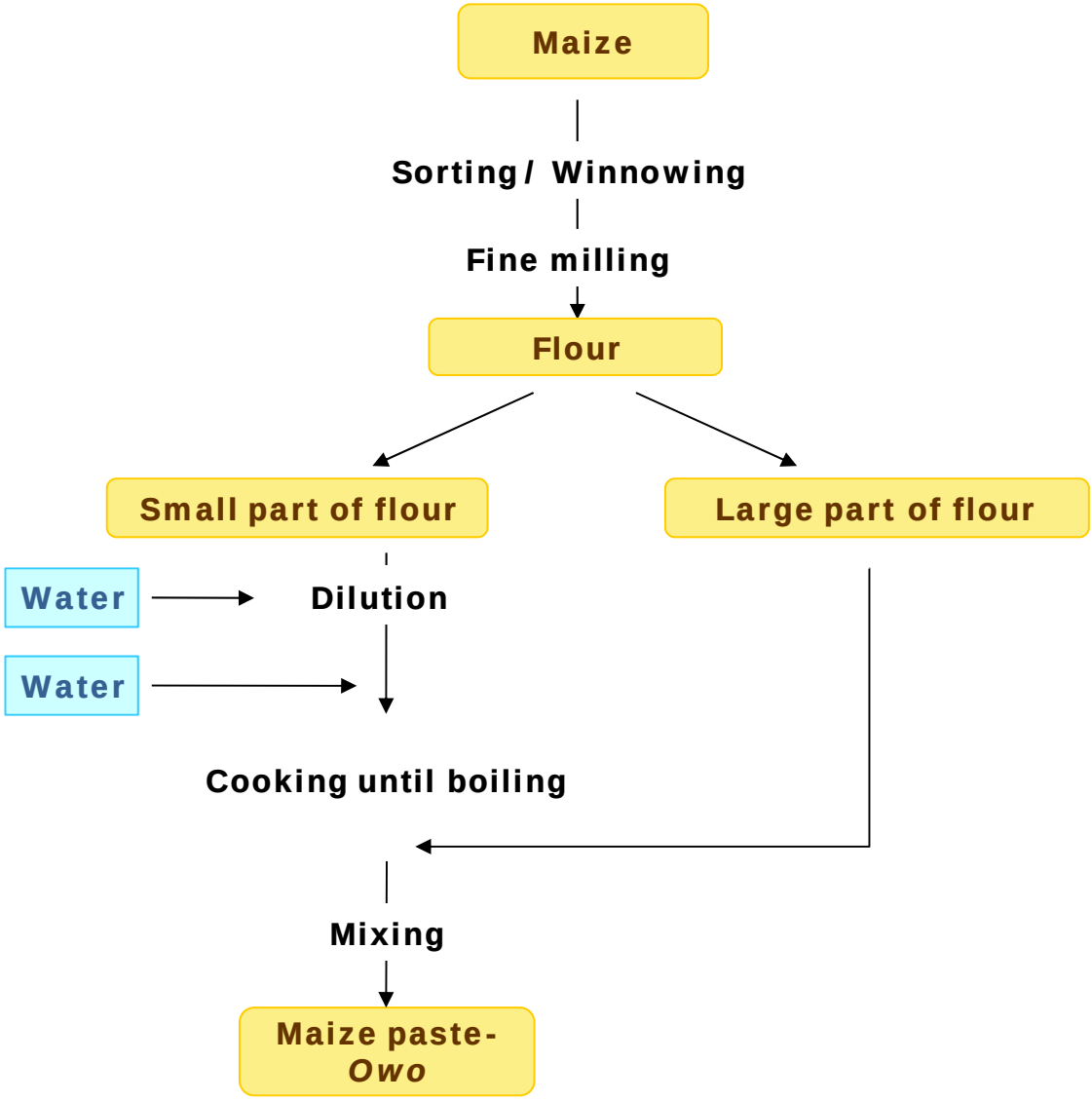
For 1000 g of maize

Ingredients		**Fresh weight** (g)
Maize	Raw grains	**1000**
	Flour	911
	Paste	4223
Water for cooking		3875

Recipe description

- Grains are cleaned by winnowing or manual sorting.
- Grains are then milled to obtain flour. No sieving is applied.
- The obtained flour is divided into two parts.
- The smallest part (between 1/3 and ½ of total flour weight) is poured in a pot containing boiling water. Sometimes, women dilute the flour in a small amount of water before pouring into the cooking pot.
- The dough is mixed while it is cooked in order to obtain a light gruel.
- About 14 min later (on average), the largest part of flour is added to the light dough and everything is thoroughly mixed with a wooden spatula.
- Cooking is carried on for 15min.

Process diagram



References

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Maize fritters - *Klèklè*

Description and uses

Klèklè corresponds to a maize dough with added aromatic ingredients and vegetables fried in oil. *Klèklè* is shaped either as a small ball or a rolled finger. It is eaten as a snack.

- **Date and place of observations**: 2009 in Cotonou.
- **Number of observations**: 5 observations in households.
- **Dry matter content** of the dish as eaten: 90.5%.
- **pH**: 5.7.

Ingredients

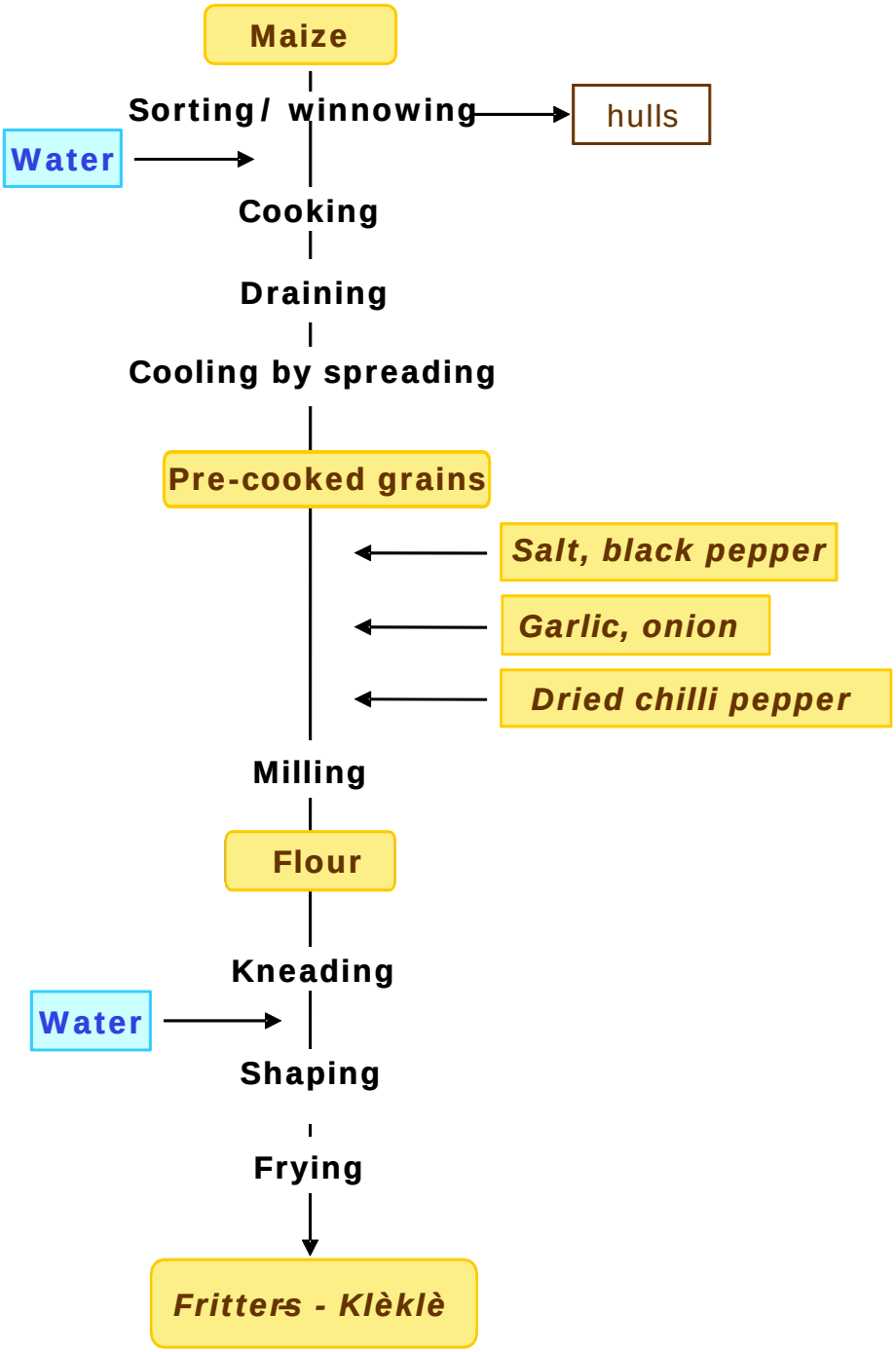
For 1000 g of maize

Ingredients		Fresh weight (g)	% DM
Maize	Raw grains	**1000**	74
	Pre-cooked grains	1310	
	Flour	1175	
Salt		18	1.5
Onion		49	0.5
Garlic		8	0.2
Black pepper		1	0.1
Dried chilli pepper		9	0.7
Oil		200	23
Water	Dough mixing	491	-

Recipe description

- Grains are first cleaned by sorting and winnowing. Then grains are cooked in boiling water for 33 min on average.
- Grains are drained and cooled by spreading.
- Onion, garlic, chilli pepper and black pepper are mixed with grains before milling.
- Water is added to the flavoured flour obtained and everything is mixed for 4 to 8 min.
- Then fritters are shaped with the hands and fried in oil.

Process diagram



References

Gnimadi M (2009). Description des modes de préparation et caractérisation de plats traditionnels fréquemment consommés par les enfants de 6 mois à 3 ans au Bénin : effets des opérations unitaires sur les teneurs en minéraux et en phytates. MSc report. University of Montpellier 2, France. 31 p.

Urban area

Sprouted and fermented maize or sorghum beverage - *Gowè*

Description and uses

Gowè is a fermented dough obtained from maize or sorghum. This dough is wrapped in leaves. For consumption, the dough is diluted into fresh cold water so that it is very appreciated during warm season.

Ingrédients

For 20 balls of dough of around 150 g

Ingredients	Fresh weight (g)
Maize or sorghum	**1000**
Leaves (from banana tree or *thalia*)	Selon besoin

Recipe description

The processing of *gowè* takes 7 to 9 days.
Maize or sorghum grains are first winnowed, sorted and/or washed to sort out the impurities. Half of the grains is let stand and the other half is used for germination.

- Germination:

Grains are first soaked in water for 24 h and then drained and spread on a jute bag placed in the bottom of a basket. Afterwards, grains are covered with a jute bag and sprayed with water twice a day. Germination occurs 3 or 4 days later. Sprouted grains are then sun-dried for 3 or 4 days.

- Milling

Not sprouted grains are blended with sprouted grains and ground into fine flour.

- First fermentation

Two thirds of the flour are mixed with water (about 0.5 L of water for 700 g of flour).
This blend is kneaded until to obtain a thick dough that is covered and exposed to sun for about 8 h. A first fermentation occurs during this stage.

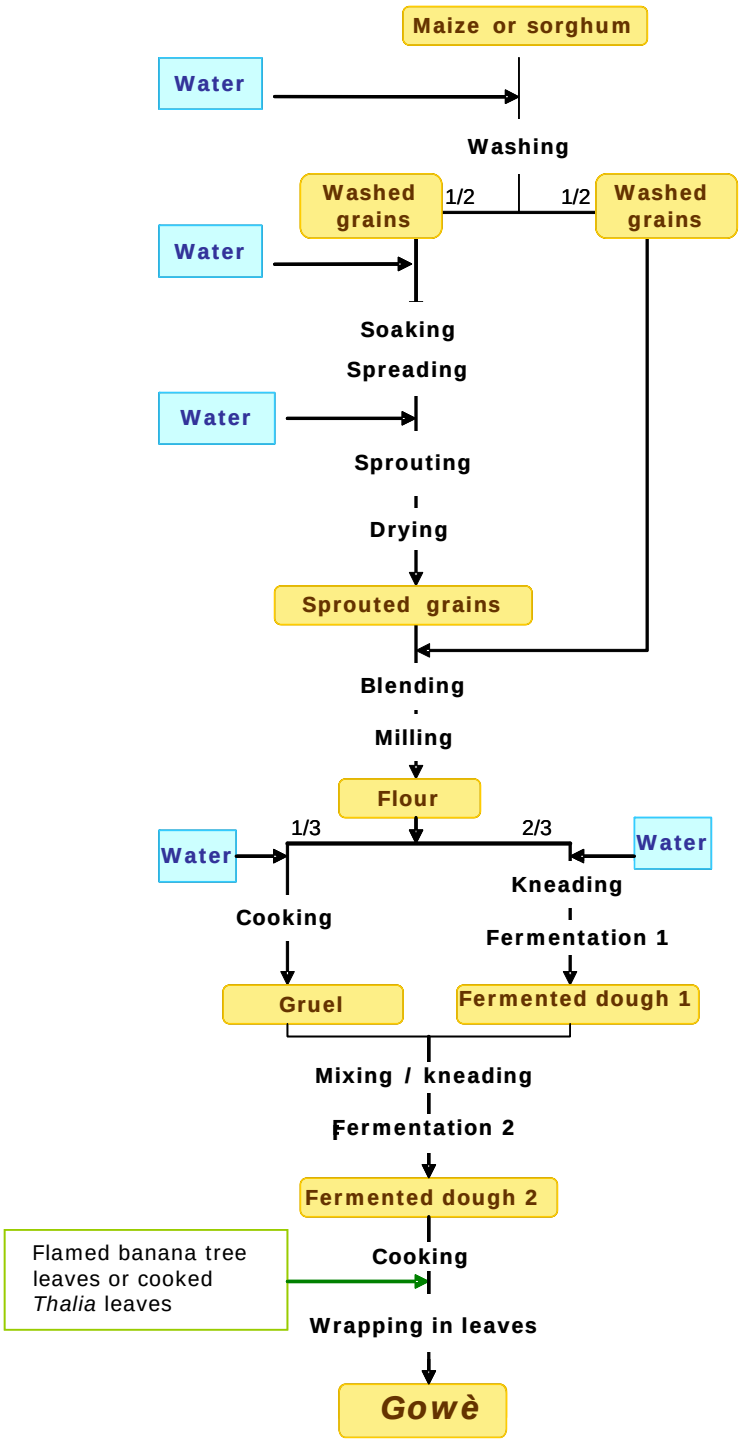
- Second fermentation

The rest of the flour (about 300-350 g) is blended with 250 mL of cold water and poured into 1 L of boiling water and cooked until to obtain a gruel. This gruel is cooled and poured on the fermented dough. This blend is mixed to obtain homogeneous dough. The dough is let stand for 8 h meanwhile a second fermentation occurs.

- Final cooking and shaping

Fermented dough is cooked for 1 h with continuous mixing. Balls of about 150 g of dough are then shaped with the hands and wrapped with leaves.
The dough is eaten after dilution in water to make a gruel and sometimes with ice or milk.

Process diagram



Gowè made from red sorghum and from white maize

References

Nago MC & Hounhouigan DJ (1998). La transformation alimentaire traditionnelle des céréales au Bénin. Les publications du CERNA. N°1. Centre Régional de Nutrition et d'Alimentation Appliquées – FSA/UNB.

II-B. Sauces

General processing of sauces

Sauces presented here have been observed in urban area in Cotonou. The names of the sauces as well as of the corresponding leaves are given in table 1.

Table 1: Name of the sauces and corresponding leaves

Sauce (name in *fon* language)	**Leaves (English name)**	**Leaves (latin name)**
Amanvivé	Bitterleaf	*Vernonia amygdalina*
Fotètè	Amaranth	*Amaranthus cruentus*
Fingninman	Cassava	*Manihot esculenta*
Fonman	Black plum	*Vitex doniana*
Gboman	African eggplant	*Solanum macrocarpon*
Soman	Celosia – cockscomb	*Celosia argentea*

The different leafy vegetable sauces observed in Benin are often prepared according to a similar process. Leaves are first blanched and drained. Then the other ingredients are prepared and cooked separately. Finally, leaves are added to the other cooked ingredients at the end of the process. Thus, the sauce recipe leaflets presented here only describe the uses and the ingredients used whereas the common general process is described below.

Blanching of leaves

Leaves are generally bought in the form of branches. Leaves are removed from the stem and sorted in order to remove all sort of contaminants. They are cut by hand and washed with water one to four times according to the observations.

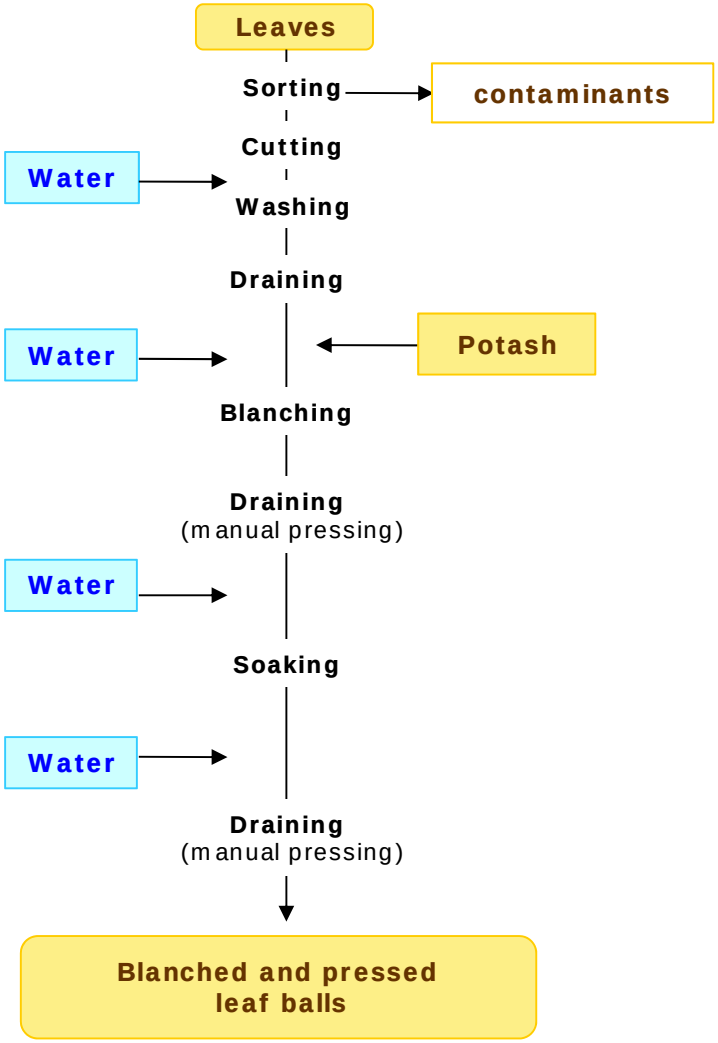
Afterward, they are blanched for 15 min on average in boiling water containing potash or bicarbonate. They are drained and manually squeezed and balls of cooked leaves are formed. The water used for blanching is discarded.
Balls of leaves are generally rinsed with water one to four times according to the leaf considered and sometimes they are once again soaked in water for 10 to 23 min (see table 2). Leaves are then drained by manual pressing. This step of soaking aims at softening the leaves and removing the acidity or bitterness (in particular for cassava and *Ocimum gratissimum* leaves).

The leaves of *Vitex doniana* are sold already blanched in the market.

Table 2: Processing of leaves for sauce preparation.

Sauce	**Blanching time (min)**			**Number of washing before blanching**	**Soaking (times observed)**	**Mean time of cooking leaves into the sauce (min)**
	Mean	Min	Max			
Amanvivé	12.4	5	25	0 to 4	2/5	5.6
Fotètè	8.8	6	13	1 to 3	0	13.0
Fingninman	18.4	9	39	0 to 2	4/5	5.8
Fonman	-	-	-	1 to 3	0	8.6
Gboman	9.8	8	13	2 to 3	0	7.0
Soman	16.8	6	46	1 to 3	2/5	12.0

Blanching diagram of leaves



Removing of stems from African eggplant leaves

Sliced Vernonia leaves

Balls of blanched cassava leaves

Preparation of sauces

Oil, (generally red palm oil) is heated up for 22 min on average. When red palm oil is used, a discoloration can be observed depending on heating time. The ingredients are generally finely ground (except for *afitin*[3] and shrimps) using a grindstone until obtaining a very fine purée. Onions and chilli peppers are ground and / or sliced before pouring (in the form of purée and/or small sliced pieces) into the cooking pot containing oil. Most of fresh ingredients (tomatoes, onions, garlic, hot chilli pepper, ginger …), spices and aromatic ingredients (afitin, black pepper, dried shrimps, *goussi*[4]) as well as fresh fish and crab are fried.

Afterward, water, stock cube and salt are added to the cooking pot.

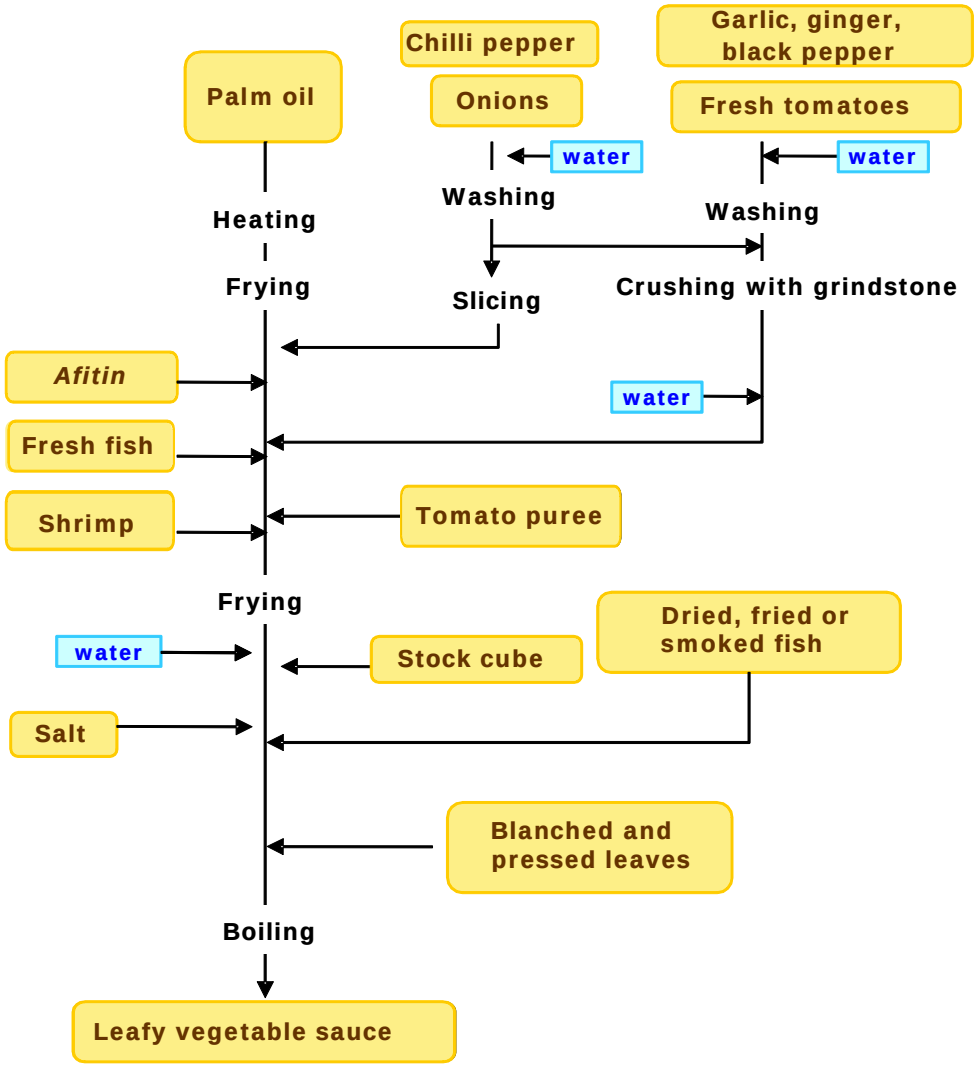
Processed ingredients such like smoked, fried or dried fish are added to the preparation as well as the blanched leaves.

Once leaves are added, the cooking is carried out for 6 to 13 min.

[3] *Afitin, also called mustard, is a condiment based on fermented seeds of P biglobosa (corresponds to the soubala in Burkina Faso).*

[4] *Goussi, also called false sesame, is prepared from pumpkin seeds*

Process diagram of sauces



Crushing ingredients with a grindstone

References

Gnimadi M (2009). Description des modes de préparation et caractérisation de plats traditionnels fréquemment consommés par les enfants de 6 mois à 3 ans au Bénin : effets des opérations unitaires sur les teneurs en minéraux et en phytates. MSc report. University of Montpellier 2, France. 31 p.

Vernonia leaf sauce – *Amanvivé* sauce

Description and uses

Amanvivé sauce

Sauce made from *Vernonia amygdalina* (corresponds to *ndolè* in Cameroun). The blanched leaves are sometimes soaked in water before to be use in the sauce preparation.

- **Date and place of observation**: 2009, in Cotonou.
- **Number of observations**: 5.
- **Mean dry matter content as eaten**: 26.8%.
- **Mean pH**: 6.3.

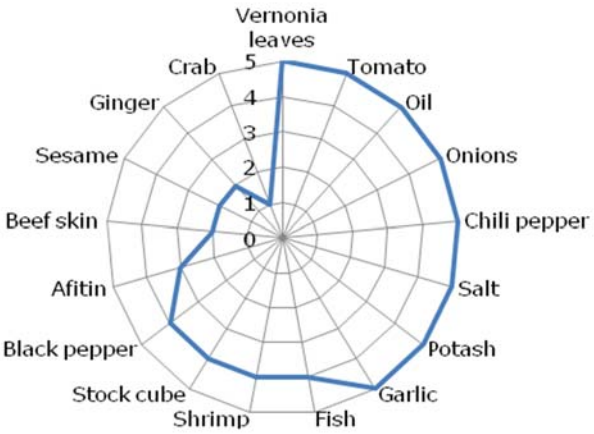
Ingredients

For 300 g of fresh leaves

Ingredients		Fresh weight (g)	% DM
***Vernonia* leaves**		**300**	13
Tomato	fresh	161	3
	purée	92	2
Oil	red palm	225	14
	groundnut	93	15
Onion, fresh		84	3
Hot chilli pepper, fresh		32	1
Salt		8	2
Potash		5	1
Garlic		5	0.4
Fish, dried		172	20
Shrimp		20	3
Stock cube		12	2
Black pepper		3	0.3
Afitin*		32	6
Beef skin		128	8
Goussi*		34	5
Ginger		9	0.2
Crab		73	1
Water		332	-

**see footnotes p 108.*

Number of observations



Vernonia amygdalina

African eggplant leaf sauce - *Gboman* sauce

Description and uses

Gboman sauce

This sauce prepared with African eggplant leaves often contains fish.

- **Date and place of observation**: 2009 in Cotonou.
- **Number of observations**: 5 observations in households.
- **Dry matter content as eaten**: 26.5%.
- **Mean pH**: 5.7.

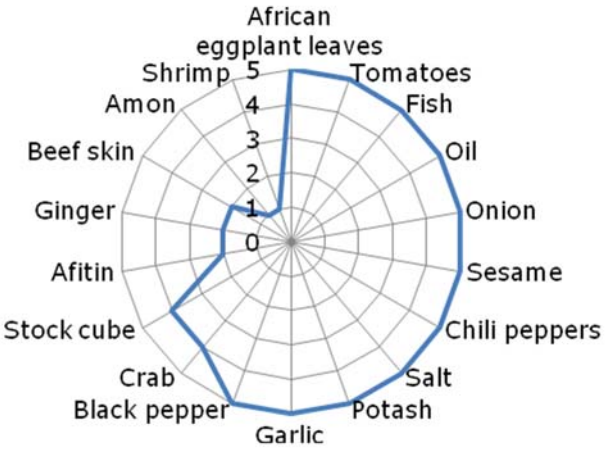
Ingredients

For 300 g of fresh leaves

Ingredients		Fresh weight (g)	% DM
Fresh african eggplant leaves		**300**	12
Tomato	fresh	245	3
	purée	26	1
Fish	fresh	175	3
	dried, smoked, fried	62.3	17
Oil	groundnut	106	11
	red palm	79	17
Onion		57	2
Goussi*		42	13
Hot chilli pepper	dried	8	0.5
	fresh	17	0.6
Salt		7	2
Potash		6	2
Garlic		2	0.1
Black pepper		1	0.2
Crab		79	4
Stock cube		5	1
Beef skin		49	2
Afitin*		23	3
Ginger		18	0.2
***Amon* (cheese)**		77	1
Smoked shrimp		3	0.2
Water		404	-

**see footnotes p 108.*

Number of observations



African eggplant leaves

Amaranth leaf sauce – *Fotètè* sauce

Description and uses

Fotètè sauce

This sauce is made with amaranth leaves that are not soaked after blanching.

- **Date and place of observation:** 2009 in Cotonou.
- **Number of observation:** 5 observations in households.
- **Dry matter content as eaten**: 26.3%.
- **Mean pH**: 5.9.

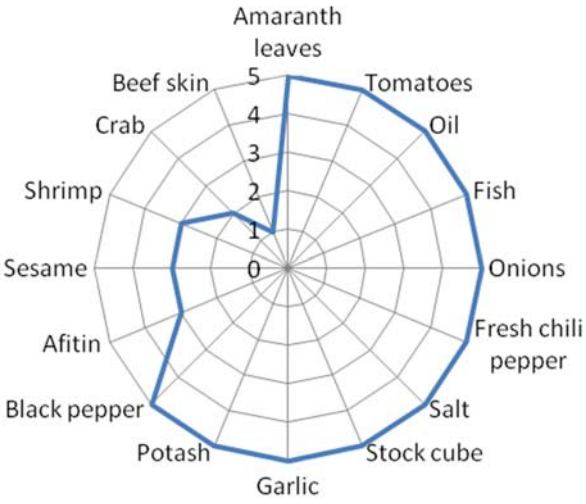
Ingredients

For 300 g of fresh leaves

Ingredients		Fresh weight (g)	%DM
Amaranth leaves		**300**	14
Oil	groundnut	306	7
	red palm	115	25
Tomato	fresh	35	3
	purée	264	1
Fish dried, smoked, fried		138	24
Onion		129	4
Hot chilli pepper, fresh		25	1
Salt		14	3
Stock cube		10	2
Garlic		8	1
Potash		7	1
Black pepper		2	1
« Goussi »*		30	3
Smoked shrimp		6	1
Afitin*		36	5
Crab		80	3
Beef skin		29	2
Water		336	-

**see footnotes p 108.*

Number of observations



Amaranth

Cassava leaf sauce - *Fingninman* sauce

Description and uses

Fingninman sauce

This sauce is made from cassava leaves. Most often, these leaves are soaked after blanching in order to decrease the bitterness.

- **Date and place of observation:** 2009 in Cotonou.
- **Number of observation**: 5 observations in households.
- **Dry matter content as eaten**: 31.8%.
- **pH**: Mean 6.4.

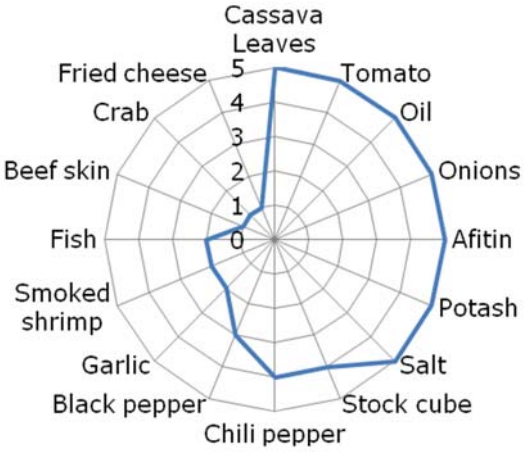
Ingredients

For 300 g of fresh leaves

Ingredients		Fresh weight (g)	%DM
Cassava leaves		**300**	24
Tomato	fresh	162	2.9
	purée	43	0.9
Red palm oil		139	35
Onion		123	5
Afitin*		51	11
Potash		9	2
Salt		5	2
Hot chilli pepper	fresh	29	1.4
	dried	6	0.4
Stock cube		8	2
Black pepper		1	0.1
Smoked or fried fish		101	7
Smoked shrimp		5	0.5
Garlic		3	0.2
Crab		94	1.4
Fried cheese		72	3
Beef skin		50	2
Water		112	-

**see footnotes p 108.*

Number of observations



Cassava leaves

Vitex doniana leaf sauce - *Fonman* sauce

Description and uses

***Fonman* sauce**

This sauce is prepared with leaves that are bought in a cooked form (already blanched).

- **Date and place of observation** : 2009 in Cotonou.
- **Number of observations** : 4 observations in households.
- **Dry matter content as eaten**: 27.0%.
- **Mean pH**: 5.7.

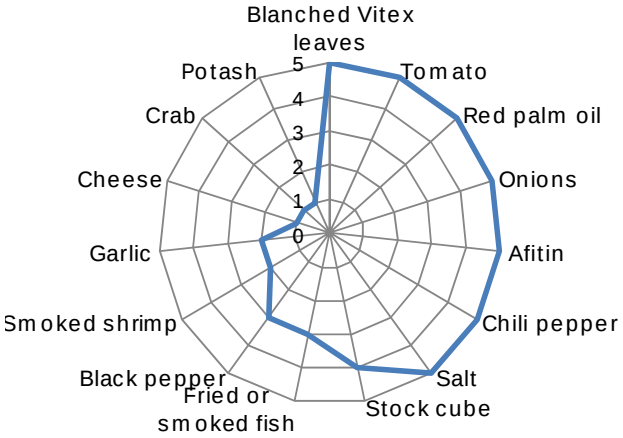
Ingredients

For 300 g of blanched leaves

Ingredients		Fresh weight (g)	%DM
***Vitex doniana* leaves**		**300**	14
Tomato	fresh	134	3
	purée	19	0.6
Red palm oil		84	44
Onion		68	4
Afitin*		23	10
Hot chilli pepper fresh		21	2
Salt		5	3
Stock cube		6	2
Fish, fried or smoked		52	11
Black pepper		0.5	0.1
Shrimp smoked		8	1
Garlic		4	0.3
Cheese		74	3
Crab		55	1
Potash		1	0.1
Water		275	-

**see footnotes p 108.*

Number of observations



***Blanched Vitex doniana* leaves**

Celosia argentea leaf sauce - *Soman* sauce

Description and uses

***Soman* sauce**

This sauce prepared with fresh leaves of *Celosia* is generally served with a maize paste.

- **Date and place of observation**: 2009 in Cotonou.
- **Number of observation**: 4 observations in households.
- **Dry matter content as eaten**: 25.4%.
- **Mean pH**: 5.8.

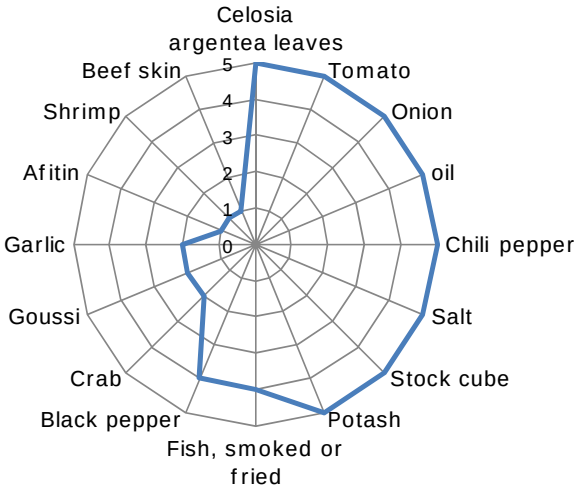
Ingredients

For 300 g of fresh leaves

Ingredients		Fresh weight (g)	%DM
***Celosia* leaves**		**300**	18
Tomato	fresh	116	2
	purée	80	5
Onion		79	5
Oil	red palm	65	19
	groundnut	46	9
Fresh hot chilli pepper		20	1.3
Salt		10	5
Stock cube		9	4
Potash		2	0.6
Fish, smoked or fried		63	20
Black pepper		3	0.7
Crab		89	3
Goussi*		35	5
Garlic		10	0.5
Afitin*		25	1
Beef skin		22	2
Smoked shrimp		4	0.3
Water		423	-

**see footnotes p 108.*

Number of observations



***Celosia argentea* leaves**

Palm nut and leaf sauce - *Denoussounou* sauce

Description and uses

Nut and leaf sauce

This sauce is prepared with red palm nut and sometimes with sliced or crushed leaves of different origin (*Vernonia*, Cassava or amaranth). It is generally eaten with maize paste.
Nuts are first poured in a cooking pot containing boiling water. Nuts are then dried and crushed in order to extract the oil. After filtration, the fibrous residue is discarded. Oil is then heated during 45 min on average before addition of the other ingredients.

- **Date and place of observations**: 2009 in Cotonou.
- **Number of observations**: 4 observations in households.
- **Dry matter content as eaten**: 22.0%.
- **Mean pH**: 5.6.

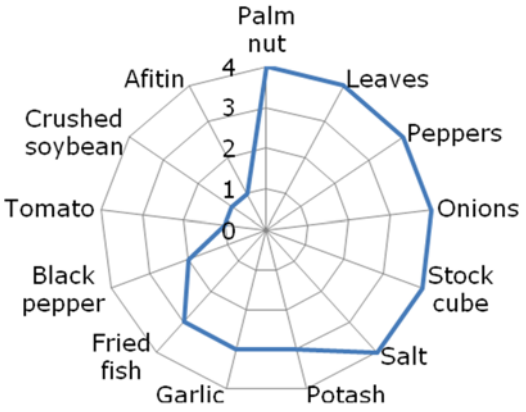
Ingredients

For 300 g of fresh palm nuts

Ingredients		Fresh weight (g)	%DM
Fresh palm nuts		**300**	52
Leaves		118	23
Onion, fresh		11	1.4
Salt		6	6.0
Hot chilli pepper	fresh	4	0.3
	dried	3	1.9
Stock cube		3	2.5
Fried mackerel		13	6.0
Potash		1	0.4
Garlic		1	0.2
Black pepper		0.3	0.3
Tomato, fresh		22	0.2
Crushed soybean		27	4.9
Afitin*		3	0.6
Water		38	-

*see footnotes p 108.

Number of observations



Crushing of cassava leaves

Palm nut sauce - *Denoussounou* sauce

Description and uses

Palm nut sauce

This sauce is made from palm nut like the previous one but no leaf is added to the preparation. It is eaten as a garnish of maize paste.

- **Date and place of observations**: 2009 in Cotonou.
- **Number of observation**: 4 observations in households.
- **Dry matter content as eaten**: 26.5%.
- **Mean pH**: 5.4.

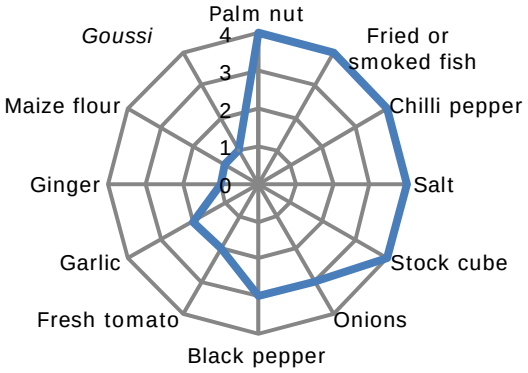
Ingredients

For 300 g of fresh palm nuts

Ingredients		Fresh weight (g)	% DM
Fresh palm nuts		**300**	61
Fish, fried or smoked		32	25
Hot chilli pepper	fresh	7	1.3
	dried	3	0.8
Salt		3	3.8
Stock cube		2	2.1
Onion		5	0.6
Black pepper		1	1.4
Tomato, fresh		13	0.5
Garlic		1	0.4
Ginger		1	0.1
White maize flour		8	1.7
Goussi*		8	2.4
Water		12	-

*see footnotes p 108.

Number of observations



Red palm nut

Fresh okra sauce – *Févi* sauce

Description and uses

Okra sauce

This sticky-sauce is made from fresh okra fruit. It constitutes a garnish of cereal-based dishes. Okra is first blanched in water containing potash and the other ingredients are directly added to the cooking pot.

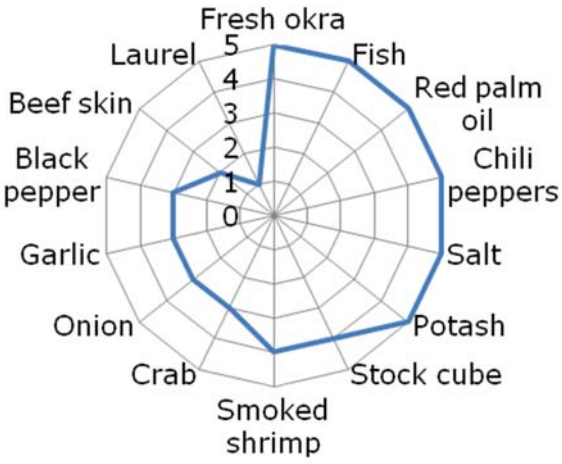
- **Date and place of observation**: 2009 in Cotonou.
- **Number of observations**: 5 observations in households.
- **Dry matter content as eaten**: 17.8%.
- **Mean pH**: 6.8.

Ingredients

For 300 g of fresh okra

Ingredients	Fresh weight (g)	%DM
Fresh okra	**300**	10
Fish dried, smoked, fried	135	42
Red palm oil	76	27
Hot chilli pepper, fresh	31	1
Salt	9	3
Potash / sodium bicarbonate	3	1
Stock cube	9	2
Smoked shrimp	5	1
Crab	122	4
Onion	42	1
Garlic	4	0.1
Black pepper	1	0.1
Beef skin	57	6
Laurel	1	0.1
Water	675	-

Number of observations



Cooking of fresh sliced okra

Glossary

Cereals

English name	Latin name	Description
Millet (pearl millet)	*Pennisetum glaucum*	Millet is a small-seeded species of cereal crop widely grown in Africa although the first producer is India. Millet production in Burkina Faso and Benin is estimated around 1.1 million tonnes and 40,000 tonnes respectively (FAO, 2007).
Maize	*Zea mays*	Maize is the cereal grain the most widely grown in the world. Several varieties are cultivated of which colour or other characteristics can differ. In 2007, Burkina Faso and Benin produced each around 900,000 tonnes and worldwide production was around 800 million tonnes.
Sorghum	*Sorghum bicolor*	Sorghum is a cereal comprising numerous species that are drought and heat resistant so that it is widely grown in tropical and subtropical areas. The sorghum kernel varies in colour from white to red or brown. In 2007, Burkina Faso and Benin produced around 1.6 million tonnes and 200,000 tonnes respectively.

Unit steps

Unit step	Description
Dehulling	Dehulling is the process of removing the envelopes and sometimes part of the germ from the grains. In households, it is made either in local mills with a stone grinder or manually by crushing to dissociate outer layers from core of the grain. Grains are then winnowed to separate the envelopes from the rest of the grains that is denser.
Crushing	Crushing can be used for cereals or other ingredients such like aromatics ingredients or condiments. Crushing is generally made with a mortar and a pestle in households.
Winnowing	This unit step aims to separate grains from impurities and outer layers. Housewives can toss the grains or drop grains from above into a bowl in order to remove the lighter impurities that are blown away.
Soaking	Soaking is the process of immersing grains in water at room temperature. This stage can stand for several hours. It is often made to prepare grains for milling.
Milling (or grinding)	Milling is generally made in local stone grinders. However, in rural area, milling can be made by crushing with a pestle in a mortar. Before milling, grains are often soaked and drained and sometimes, aromatics ingredients are added.
Settling	Settling consists in letting stand wet dough or grains in water. Lactic acid fermentation generally occurs during this unit step.
Filtration	Filtration through muslin consists in separating the components of cereal dough obtained after soaking and milling, in order to remove draff that is mainly made of envelopes.
Cooking	Cooking is most often realised over a wood fire and in a cooking pot.

Part two

Nutritional value of main dishes

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Introduction

In Burkina Faso and Benin, young children generally consume gruels or family food in complement of breast milk. Meals generally consist in a cereal-based dish served with a sauce.
This part describes the nutritional composition of the dishes the most frequently eaten by young children in Burkina Faso and Benin. It also contains data on the leafy vegetables (and fruits) commonly used to prepare sauces in these countries. These leafy vegetables have been identified as potential interesting sources of micronutrients such as iron, zinc or carotenoids (provitamin A).

Material

The different cereal-based dishes analysed are listed in table 1. Leaves, fruits as well as the local name of corresponding sauces are listed in tables 2 and 3.

Table 1 : Description and names of cereal-based dishes from Burkina Faso and Benin

Country	Cereal-based dish description	Local name
Burkina Faso	Millet-based pancakes	*Massa*
	Fermented gruel (not sweetened)	*Ben-saalga* or *Ben-kida*
	White maize dough	*Tô*
	White sorghum dough	*Tô*
Benin	Maize-based fermented dough	*Akassa*
	Cooked maize paste	*Owo*
	Maize fritters	*Klèklè*
	Fermented maize dough	*Mawè*
	Fermented maize-based gruel (made from mawè)	*Aklui*
	Fermented maize-based gruel	*Gbangba*

Table 2: Some leaves and fruit used in sauces in Burkina Faso

Latin name	Common english name	Common french name	Local name
Hibiscus esculentus	Okra	Gombo	*Mâna*
Hibiscus sabdariffa	Roselle	Oseille	*bito, dâ*
Gynandropsis gynandra			*Kenebdo*
Solanum nigrum	Black nightshade	Morelle noire	*Loudo*
Corchorus olitorius	Jute	Corète	*Bulvaka*
Amaranthus (hybridus or cruentus)	(Smooth, red) Amaranth	Amarante	*Burum buri*
Solanum macrocarpon S. aethiopicum	Ethiopian eggplant Aubergine	Aubergine indigène Aubergine amère	*Kumba*
Vigna unguiculata	Cowpea	Niébé, haricot cornille, dolique à œil noir	*Bengedo*
Basella alba	Malabar spinach, Malabar nightshade	Epinards de Malabar	*Epinaré*
Adansonia digitata	Baobab	Baobab	*Touega, Toega*
Cassia tora* or *Senna obtusifolia	Sicklepod		*Kirikiri*
***Ceiba pentandra* (Calyces of the kapok's flowers)**	Kapok	Kapok	*Voaga*

Table 3: Some leaves and fruits used in sauces in Benin

Plant origin	Leaves, fruits or nuts		Sauces
Latin name	**Common english name**	**Common french name**	**Local name**
Ocimum Gratissimum L	Wild basil	Basilic arbustif	*Tchiayo*
Vernonia amygdalina	Bitter leaf	Vernonie	*Amanvivé*
Solanum macrocarpon L	African eggplant	Grande morelle	*Gboman*
Amaranthus cruentus	Red amaranth	Amarante rouge	*Fotètè*
Manihot esculenta	Cassava	Manioc	*Fingninman*
Vitex doniana	Black plum	Prune noire	*Fonman*
Celosia argentea	Cockscomb	Célosie	*Soman*
Elaeis guineensis Jacq.	Red palm nut	Noix de palme	*Denoussounou*
Hibiscus esculentus	Okra	Gombo (fruit)	*Févi*

Methods

a- Description of the preparation and sampling of the dishes

Cereal-based dishes and sauces

Processing methods of different leafy vegetable sauces and cereal-based dishes were followed in several households (n = 1 to 6) except for *ben-saalga* and *ben-kida* (n=47). At the end of preparation, two samples of final products were collected and taken back to the laboratory where they were frozen.

For each sauce and cereal-based dish, one sample was freeze-dried and crushed before analysis for proximate, phytate and mineral composition. The other frozen samples were used to determine carotenoids and retinol contents.

In some cases, average samples were prepared by mixing equal amounts (2g) of fresh or freeze-dried leaves corresponding to the same variety. These average samples were used to determine the dry matter content (on fresh leaves) and lipid content (on freeze-dried samples) of some leaves.

Leafy vegetables

Most leaves were bought in markets or market gardeners in Benin and Burkina Faso. Most of them have been bought as fresh leaves but some were also or only found in a dried form in Burkina Faso (jute, *Cassia tora*, baobab). Fresh *moringa* leaves cultivated in a field near Ouagadougou and powder of *moringa* leaves from Togo were sampled with the support of the Moringanews network.

Fresh leaves were washed twice in tap water and once with deionised water after removing of main stems. Washed leaves were either freeze-dried and crushed for analyses of proximate, phytate and mineral composition, or only frozen for carotenoid and retinol analyses.

b- Biochemical analysis

Proximate composition

Dry matter (DM) contents were determined by oven drying at 105°C to constant weight on fresh samples.

Protein contents (*N* x 6.25) were determined by the method of Kjeldahl (standard NF. V03-050, AFNOR, 1970).

Lipid contents were extracted with ether oil using the HT6 Soxtec system (Tecator, Höganäs, Sweden).

ADF contents, which correspond approximately to cellulose and lignin contents, were determined by the gravimetric method of Van Soest (1963) using a Fibertec 1020 (Foss, Hillerod, Denmark).

Ash contents were determined by calcination in a furnace at 530°C.

Energy densities were calculated by using the coefficients 4 kcal/g DM (16.7 kJ/g DM) for protein and available carbohydrate (estimated by difference) and 9 kcal/g DM (37.6 kJ/g DM) for lipid and taking into account the dry matter content.

Determination of Fe and Zn content

Total Fe and Zn contents were determined by atomic absorption spectrophotometry (AA800, Perkin Elmer, Les Ulis, France) after a progressive mineralisation for 48 h at 500° C (adapted from 14082 NF EN ISO standard) or microwave digestion using an Ethos 1 microwave digestor (Milestone, Sorisole, Italy) during 15 min at 200 °C and 1500W.

Determination of IP6 content

After extraction in acid solution (HCl 0.5 M) at 100°C for 6min, myo-inositol hexaphosphate (IP6) content was determined by anion-exchange HPLC separation, according to the method of Talamond et al. (1998) and modified by Lestienne et al. (2005).

Determination of carotenoid and retinol content

Frozen samples were extracted in ethanol/hexane 4/3 according to the method of Taungbodhitham et al. (1998). Sample extracts were then analysed for β-cryptoxanthine, β-carotene, α-carotene, all-*trans*-retinol) by HPLC using a polymeric column YMC-30 (YMC Inc., Wilmington NC) and a UV-visible photodiode array detector (Dionex UVD 340U). Chromatographs were analysed at the wavelength of maximum absorption of the carotenoids and all-*trans* retinol in the mobile phase, respectively 450 nm and 320 nm. Retinol activity equivalents (RAE) were calculated using a conversion factor of 12 for β-carotene and of 24 for other provitamins A (α-carotene, β-cryptoxanthine) for 1 retinol and expressed in µg RAE /100 g DM (Murphy 2002). The retinol content of samples containing meat was determined after saponification according to the AOAC 992.06 method (AOAC 2005).

Results

Tables 4 to 9 indicate the nutritional composition of dishes and ingredients collected in Burkina Faso and Benin.

Table 4: Composition of cereal-based dishes from Burkina Faso.

Sample name		pH	Dry matter content	Lipids	ADF fibers	Proteins	Ash	Iron	Zinc	IP6	Energy	
			%	g/100g DM				mg/ 100g DM			Kcal/ 100g DM	Kcal/ 100g wet basis
Pancakes n=8	**Mean**	**nd**	**58.40**	**21.66**	**2.96**	**5.74**	**0.89**	**4.15**	**1.49**	**256**	**493**	**290**
	SD	-	*5.31*	*7.42*	*0.26*	*0.40*	*0.18*	*3.71*	*0.23*	*57*	*37*	*46*
	min	-	51.08	8.96	2.64	5.17	0.69	2.67	1.22	186	431	224
	max	-	66.97	30.81	3.42	6.29	1.32	5.06	1.95	331	540	358
Fermented millet gruel *(without sugar) ben-kida/ben-saalga* n=47	**Mean**	**nd**	**6.61**	**4.69**	**2.14**	**8.22**	**1.41**	**8.33**	**2.05**	**220**	**410**	**27**
	SD	-	*1.03*	*0.76*	*0.48*	*0.87*	*0.20*	*2.83*	*0.51*	*90*	*4*	*4*
	min	-	5.02	2.54	1.27	5.77	0.90	3.82	1.07	50	400	21
	max	-	10.24	6.63	3.18	9.96	1.82	15.00	3.20	44	418	42
White maize *Tô* n=4	**Mean**	**5.18**	**16.42**	**0.43**	**3.01**	**7.89**	**0.17**	**4.82**	**0.42**	**254**	**370**	**61**
	SD	*0.40*	*0.70*	*0.13*	*0.82*	*0.84*	*0.09*	*0.60*	*0.12*	*46*	*3*	*3*
	min	4.70	15.63	0.26	1.96	7.09	0.06	4.25	0.29	204	366	58
	max	5.69	17.40	0.60	4.00	9.29	0.27	5.83	0.60	311	377	65
White sorghum *Tô* n=5	**Mean**	**4.27**	**17.14**	**0.96**	**7.04**	**10.19**	**1.28**	**45.36**	**1.83**	**333**	**359**	**62**
	SD	*0.30*	*1.75*	*0.47*	*0.71*	*0.62*	*0.50*	*29.89*	*0.64*	*193*	*3*	*6*
	min	3.98	15.07	0.66	6.08	9.25	0.75	10.19	1.28	108	356	55
	max	4.78	19.97	1.90	7.97	10.76	2.22	98.92	3.04	596	363	71

Table 5: Composition of sauces from Burkina Faso

Sample name		pH	Dry matter content	Lipids	ADF fibers	Proteins	Ash	Iron	Zinc	IP6	Beta-caroten	Vitamin A	Energy	
			%	g/100g DM				mg/ 100g DM				µg RAE/100g DM	Kcal/ 100g DM	Kcal/ 100g wet basis
Bulvaka sauce	**Mean**	**7.11**	**13.86**	**36.38**	**4.59**	**26.22**	**15.24**	**25.88**	**2.99**	**93**	**5.1**	**580**	**503**	**73**
fresh leaves	*SD*	*0.94*	*4.71*	*10.09*	*1.46*	*3.86*	*5.64*	*10.45*	*1.11*	-	*6.6*	*815*	*77*	*30*
n=4	Min	6.36	5.91	20.31	2.99	19.56	11.27	16.54	2.05	-	<0.3	<25	375	22
For IP6, n=1	Max	8.69	18.17	47.10	6.77	28.92	24.92	42.78	4.88	-	16.35	1986	578	99
Bulvaka sauce	**Mean**	**6.71**	**13.06**	**33.12**	**5.85**	**25.18**	**15.49**	**16.68**	**2.33**	**77**	**<0.3**	**<25**	**480**	**64**
dried leaves	*SD*	*0.65*	*3.24*	*8.88*	*2.23*	*10.77*	*5.67*	*4.78*	*0.46*	-	-	-	*73*	*24*
n=5	Min	6.02	8.72	23.93	3.09	12.61	7.39	8.33	1.46	-	-	-	425	38
For IP6, n=1	Max	7.63	16.29	46.04	9.49	43.89	19.47	17.90	2.63	-	-	-	585	95
Kirikiri sauce	**Mean**	**7.39**	**15.53**	**42.94**	**7.79**	**19.57**	**16.75**	**39.56**	**2.00**	**361**	**12.2**	**1237**	**517**	**79**
fresh leaves	Min	7.09	13.22	30.25	6.66	19.29	14.72	11.35	1.61	355	12.1	1185	441	78
n=2	Max	7.70	17.84	55.63	8.92	19.84	18.77	67.76	2.38	367	12.4	1289	593	79
	Mean	**7.47**	**23.61**	**48.36**	**7.69**	**19.06**	**13.45**	**9.22**	**1.92**	**nd**	**6.0**	**499**	**557**	**132**
Kirikiri sauce	*SD*	*0.27*	*1.82*	*3.65*	*0.62*	*3.22*	*1.65*	*1.18*	*0.45*	-	*3.1*	*260*	*13*	*13*
dried leaves	Min	7.09	21.86	44.91	6.89	15.01	11.13	7.71	1.59	-	2.1	177	545	119
n=3	Max	7.66	26.12	53.40	8.40	22.88	14.77	10.60	2.55	-	9.8	814	574	150
	Mean	**8.30**	**9.89**	**12.07**	**9.89**	**21.48**	**26.14**	**8.37**	**5.52**	**nd**	**14.0**	**1167**	**316**	**31**
Baobab sauce	*SD*	*0.26*	*1.36*	*1.78*	*3.30*	*4.11*	*1.51*	*6.81*	*3.05*	-	*5.4*	*448*	*22*	*5*
fresh leaves	Min	8.05	8.76	10.20	7.25	15.66	24.32	1.28	2.71	-	8.6	719	288	26
n=3	Max	8.56	11.80	14.46	14.54	24.64	28.03	17.55	9.76	-	19.4	1615	339	38
Baobab sauce dried leaves	**n=1**	**5.66**	**10.67**	**22.82**	**7.42**	**21.84**	**30.14**	**108.95**	**4.01**	**130**	**5.0**	**420**	**364**	**39**

nd = not determined

Table 5 (continued): Composition of sauces from Burkina Faso

Sample name		pH	Dry matter content	Lipids	ADF fibers	Proteins	Ash	Iron	Zinc	IP6	Beta-caroten	Vitamin A	Energy	
			%	g/100g DM				mg/ 100g DM				µg RAE/100g DM	Kcal/ 100g DM	Kcal/ 100g wet basis
Baobab sauce (powder of dried baobab leaves)	**n=1**	**nd**	**10.50**	**7.62**	**8.22**	**30.49**	**22.84**	**11.90**	**3.89**	**nd**	nd	nd	**314**	**33**
Roselle sauce n=5	**Mean**	**5.26**	**18.69**	**42.73**	**5.58**	**18.72**	**12.77**	**25.59**	**2.27**	**380**	**5.4**	**449**	**540**	**102**
	SD	*0.44*	*6.59*	*7.14*	*1.17*	*6.04*	*2.39*	*22.33*	*0.68*	-	*5.0*	*420*	*37*	*38*
	Min	4.67	7.59	31.02	3.55	11.70	9.88	9.71	1.20	-	<0.3	<25	488	40
	Max	5.88	24.99	53.08	6.96	29.71	15.89	69.09	3.07	-	11.4	952	604	145
Babenda n=6	**Mean**	**5.16**	**15.03**	**9.90**	**6.23**	**22.01**	**4.96**	**18.26**	**3.07**	**nd**	**15.9**	**1361**	**408**	**61**
	SD	*1.44*	*4.35*	*4.95*	*1.06*	*6.12*	*1.61*	*5.88*	*1.22*	-	*12.7*	*1097*	*26*	*16*
	Min	3.88	10.24	5.96	4.99	15.77	2.49	13.47	2.00	-	5.3	443	378	42
	Max	8.28	23.43	19.72	8.41	30.53	6.86	29.17	5.25	-	39.0	3249	453	89
Dried okra sauce	**n=1**	**nd**	**14.15**	**37.38**	**4.46**	**25.81**	**16.13**	**10.89**	**2.36**	**114**	nd	nd	**505**	**71**
Fresh okra sauce	**n=1**	**nd**	**8.39**	**5.13**	**11.21**	**32.04**	**24.65**	**23.01**	**3.61**	**59**	nd	nd	**282**	**24**
Fresh okra sauce and fish + tomato	**n=1**	**nd**	**14.79**	**39.86**	**4.55**	**24.08**	**17.60**	**3.93**	**1.98**	**85**	nd	nd	**511**	**76**

Table 6: Composition of leaves and okra fruit from Burkina Faso.

Sample name		n	Dry matter content	Lipids	ADF fibers	Proteins	Ash	Iron	Zinc	IP6	beta-caroten	Vitamin A	Energy	
			%	g/100g DM				mg/ 100g DM				µg RAE/100g DM	Kcal/ 100g DM	Kcal/ 100g wet basis
Hibiscus esculentus (okra)	fresh	1	9.45	0.21	15.00	17.02	10.55	5.53	4.88	nd	9.0	748	299	28
	dried	1	89.39	0.90	13.61	18.55	10.66	15.18	5.40	132	0.5	43	307	275
Hibiscus sabdariffa*	fresh	2	11.40	2.29	10.34	24.22	9.80	83.36	3.77	14	23.4	1952	331	38
Gynandropsis gynandra	fresh	1	10.17	*nd*	10.64	34.75	17.83	70.98	4.73	nd	52.2	4421	*nd*	*nd*
Solanum nigrum	fresh	1	9.32	4.39	14.04	37.29	16.87	100.70	6.51	nd	51.4	4443	298	28
Solanum incanum	fresh	1	13.56	3.31	16.11	31.04	19.96	91.59	2.20	nd	26.2	2215	272	37
Cowpea leaves	fresh	1	11.87	2.20	12.60	33.80	11.64	51.67	3.39	8	18.4	1593	314	37
Malabar spinach leaves	fresh	1	6.66	3.38	9.45	26.78	21.91	38.35	15.84	5	13.7	1202	292	19
Amaranthus hybridus/ cruentus	fresh	2	10.96	1.16	12.42	33.57	20.74	103.00	6.32	24	26.8	2328	273	30
Corchorus olitorius	fresh	1	12.25	1.91	10.97	32.32	13.48	55.53	4.07	14	29.3	2488	312	38
	dried	1	93.35	1.69	14.74	22.54	13.28	42.81	3.43	37	*nd*	*nd*	296	277
Cassia tora	fresh	1	93.23	*nd*	12.67	24.60	14.89	22.16	2.42	10	*nd*	*nd*	290	270
	dried	1	92.72	1.29	13.10	27.57	12.77	103.42	2.93	19	2.8	234	303	281
Baobab leaves	fresh	1	28.80	1.86	nd	5.29	nd	16.74	3.44	nd	7.0	579	*nd*	*nd*
	dried	1	93.56	3.19	16.86	10.89	13.83	95.35	1.75	12	1.6	130	293	274
Kapok calyces	dried	1	88.03	0.25	24.06	8.79	9.99	10.12	2.39	nd	<0.3	2	265	233

**determination of carotenoids on one sample only*

Table 7: Composition of cereal-based dishes from Benin.

Sample name		Dry matter content	Lipids	ADF fibers	Proteins	Ash	Iron	Zinc	IP6	Energy	
		%	g/100g DM				mg/100g DM			Kcal/ 100g DM	Kcal/ 100g wet basis
Mawè n=5	**Mean**	**7.47**	**2.09**	**3.94**	**7.66**	**1.82**	**6.95**	**1.53**	**98**	**387**	**29**
	SD	0.75	0.78	0.54	2.22	0.97	2.99	0.67	59	5	3
	Min	6.59	0.81	2.91	4.17	0.56	4.08	0.62	38	381	26
	Max	8.44	3.06	4.40	9.82	3.35	12.66	2.70	198	392	33
Mawè* gruel - *Aklui n=2	**Mean**	**15.00**	**1.67**	**2.67**	**8.02**	**0.51**	**4.69**	**0.68**	**nd**	**396**	**59**
	Min	12.50	1.58	1.50	7.88	0.38	3.87	0.68	-	392	50
	Max	17.50	1.75	3.84	8.15	0.63	5.50	0.68	-	399	69
***Gbangba* gruel** n=2	**Mean**	**12.27**	**3.80**	**3.83**	**7.84**	**1.52**	**3.19**	**2.39**	**335**	**398**	**49**
	Min	9.89	3.03	3.27	4.85	1.31	2.34	1.23	240	397	39
	Max	14.64	4.57	4.39	10.82	1.72	4.04	3.63	430	398	58
Akassa n=5	**Mean**	**14.70**	**4.91**	**6.73**	**8.75**	**1.25**	**6.29**	**2.35**	**299**	**393**	**58**
	SD	1.45	0.37	0.63	1.56	0.37	2.27	0.66	103	3	6
	Min	12.62	4.22	5.80	6.59	0.65	4.40	1.20	172	389	51
	Max	16.66	5.31	7.78	10.67	1.78	10.61	3.07	437	398	66
Owo n=5	**Mean**	**20.26**	**4.33**	**6.65**	**8.91**	**1.33**	**5.54**	**2.40**	**387**	**390**	**80**
	SD	1.50	0.15	1.35	1.43	0.06	1.77	0.47	22	6	5
	Min	17.76	4.19	5.72	6.69	1.27	2.68	1.83	360	379	71
	Max	22.48	4.57	9.30	10.14	1.44	8.00	3.03	416	395	86
Klèklè n=5	**Mean**	**90.49**	**23.11**	**3.80**	**7.08**	**2.43**	**5.68**	**2.05**	**236**	**491**	**444**
	SD	2.01	6.69	0.15	0.66	0.57	1.20	0.19	312	31	22
	Min	88.05	11.95	3.64	6.18	1.35	4.05	1.82	210	439	412
	Max	93.85	30.60	4.03	7.84	2.93	7.17	2.30	297	527	478

Table 8: Composition of sauces from Benin

Sample name		pH	Dry matter content	Lipids	ADF fibers	Proteins	Ash	Iron	Zinc	IP6	beta-caroten	Vitamin A	Energy	
			%	g/100g DM				mg/ 100g DM				µg RAE/100g DM	Kcal/ 100g DM	Kcal/ 100g wet basis
Amanvivè n=5	**Mean**	**6.31**	**27.56**	**46.25**	**7.70**	**22.59**	**11.47**	**10.86**	**2.64**	**220**	**14.8**	**1377**	**555**	**154**
	SD	*0.74*	*6.57*	*6.05*	*1.65*	*5.69*	*2.42*	*3.16*	*0.56*	*199*	*3.9*	*331*	*37*	*43*
	Min	5.69	17.79	35.84	4.78	11.66	8.02	7.20	1.96	48	10.5	948	500	98
	Max	7.74	38.49	53.20	9.33	28.27	14.72	16.65	3.67	496	20.1	1831	596	229
Gboman n=5	**Mean**	**5.68**	**26.55**	**53.38**	**5.76**	**23.85**	**8.07**	**9.00**	**2.96**	**474**	**9.0**	**847**	**612**	**162**
	SD	*0.35*	*3.56*	*2.77*	*0.89*	*3.02*	*1.86*	*1.69*	*0.68*	*48*	*3.3*	*315*	*21*	*19*
	Min	5.13	22.85	49.26	4.29	19.26	6.16	5.77	1.89	396	6.8	576	578	138
	Max	6.16	31.64	57.52	6.73	27.32	10.99	10.26	4.00	523	15.6	1437	638	184
Fotètè n=5	**Mean**	**5.91**	**26.34**	**50.93**	**6.12**	**22.98**	**9.74**	**8.25**	**2.83**	**171**	**18.6**	**1815**	**591**	**157**
	SD	*0.25*	*6.15*	*9.01*	*1.62*	*6.91*	*2.08*	*1.31*	*0.41*	*165*	*9.1*	*823*	*51*	*45*
	Min	5.53	21.58	41.82	4.00	12.93	7.59	6.79	2.12	14	6.8	609	523	117
	Max	6.15	37.94	65.04	8.07	30.96	13.59	10.15	3.26	398	31.3	2672	673	232
Fingninman n=5	**Mean**	**6.44**	**31.77**	**52.35**	**7.13**	**17.08**	**6.52**	**7.77**	**2.36**	**89**	**24.8**	**2245**	**607**	**196**
	SD	*0.16*	*8.93*	*8.71*	*1.37*	*5.70*	*1.52*	*2.24*	*0.61*	*20*	*3.6*	*333*	*46*	*68*
	Min	6.21	17.13	42.54	5.40	10.92	4.64	5.22	1.27	63	20.5	1849	566	103
	Max	6.64	44.87	68.47	9.26	26.52	8.88	11.21	3.16	118	29.2	2621	692	311
Fonman n=5	**Mean**	**5.73**	**26.98**	**51.87**	**11.21**	**12.79**	**8.01**	**8.24**	**1.72**	**63**	**20.1**	**2723**	**583**	**158**
	SD	*0.26*	*7.60*	*4.92*	*0.73*	*1.91*	*1.55*	*0.75*	*0.32*	*13*	*12.9*	*1488*	*23*	*49*
	Min	5.38	20.32	46.11	10.44	11.23	5.90	7.22	1.19	48	8.1	1157	553	118
	Max	6.03	40.94	58.14	12.45	16.45	10.73	9.52	2.19	81	43.9	5456	615	252

Table 8 (continued): Composition of sauces from Benin

Sample name		pH	Dry matter content	Lipids	ADF fibers	Proteins	Ash	Iron	Zinc	IP6	beta-caroten	Vitamin A	Energy	
			%	g/100g DM				mg/ 100g DM				µg RAE/100g DM	Kcal/ 100g DM	Kcal/ 100g wet basis
Soman n=5	**Mean**	**5.81**	**25.41**	**49.05**	**6.24**	**20.63**	**11.81**	**11.43**	**4.15**	**184**	**21.2**	**1932**	**573**	**146**
	SD	*1.02*	*3.06*	*2.49*	*1.25*	*6.96*	*2.91*	*1.75*	*1.06*	*196*	*12.2*	*1127*	*23*	*21*
	Min	4.90	20.79	46.18	4.77	11.99	8.71	9.38	3.05	34	6.6	549	537	112
	Max	7.24	28.64	53.15	8.02	29.77	16.07	13.46	5.92	481	41.0	3733	606	167
Févi **- Okra** n=5	**Mean**	**6.80**	**17.81**	**39.57**	**4.60**	**25.43**	**17.81**	**7.95**	**2.78**	**33**	**16.3**	**1988**	**508**	**91**
	SD	*0.07*	*5.29*	*8.09*	*0.62*	*5.10*	*5.29*	*4.22*	*0.52*	*12*	*6.6*	*910*	*29*	*29*
	Min	6.72	12.95	29.61	3.42	21.08	12.95	4.29	2.12	21	7.5	730	476	62
	Max	6.90	27.60	49.21	5.10	33.64	27.60	15.71	3.45	52	23.9	3341	558	141
Denoussounou *with fresh leaves* n=4	**Mean**	**nd**	**22.20**	**59.84**	**6.54**	**13.02**	**8.94**	**6.81**	**1.16**	**100**	**34.3**	**2858**	**637**	**141**
	SD	-	*2.05*	*5.21*	*1.42*	*2.78*	*0.40*	*0.69*	*0.52*	*149*	*5.9*	*1571*	*25*	*11*
	Min	-	18.68	52.96	4.84	9.28	8.27	6.05	0.71	0	25.5	0	609	122
	Max	-	23.66	65.10	8.58	16.19	9.30	7.78	2.01	364	42.1	4375	668	153
Denoussounou *without leaves* n=4	**Mean**	**nd**	**26.50**	**66.75**	**3.09**	**12.47**	**8.13**	**7.72**	**2.36**	**248**	**26.2**	**2545**	**689**	**185**
	SD	-	*8.55*	*10.67*	*0.35*	*7.05*	*2.92*	*2.51*	*0.69*	*327*	*12.0*	*2042*	*57*	*70*
	Min	-	20.89	48.66	2.62	5.96	5.51	5.22	1.27	*68*	13.6	0	598	133
	Max	-	41.29	74.90	3.59	24.17	13.02	11.21	3.16	737	38.7	5361	740	306

Table 9: Composition of leaves and okra fruit from Benin.

Sample name		Dry matter content	Lipids	ADF fibers	Proteins	Ash	Iron	Zinc	IP6	beta-caroten	Vitamin A	Energy	
		%	g/100g DM				mg/ 100g DM				µg RAE/100g DM	Kcal/ 100g DM	Kcal/ 100g wet basis
Ocimum gratissimum L. *Fresh leaves* n=5	**Mean**	**13.96**	**4.31**	**17.00**	**22.37**	**11.20**	**16.96**	**6.85**	**13**	**24.9**	**2162**	**309**	**43**
	SD	-	-	*1.61*	*1.38*	*1.21*	*4.87*	*2.83*	-	*7.0*	*562*	*10*	*1*
	Min	-	-	14.57	20.92	9.67	10.15	3.23	-	15.7	1376	293	41
	Max	-	-	19.33	24.84	12.71	22.35	9.88	-	37.3	3107	324	45
Vernonia *Fresh leaves* n=5	**Mean**	**14.26**	**3.37**	**17.91**	**22.65**	**12.07**	**13.40**	**7.11**	**30**	**20.3**	**1763**	**297**	**42**
	SD	-	-	*4.39*	*0.89*	*0.45*	*1.03*	*0.52*	-	*2.3*	*192*	*16*	*2*
	Min	-	-	14.46	21.34	11.45	12.37	6.56	-	17.5	1542	265	38
	Max	-	-	26.59	23.69	12.70	15.27	7.80	-	23.4	2009	309	44
Amaranth *Fresh leaves* n=5	**Mean**	**15.79**	**4.11**	**12.93**	**22.71**	**17.49**	**21.67**	**16.44**	**30**	**31.0**	**2654**	**299**	**47**
	SD	-	-	*0.36*	*1.41*	*0.54*	*1.81*	*1.75*	-	*6.8*	*599*	*3*	*1*
	Min	-	-	12.48	21.86	16.84	19.88	13.72	-	22.0	1825	293	46
	Max	-	-	13.49	25.52	18.40	24.59	18.95	-	39.6	3428	301	48
Celosia argentea *Fresh leaves* n=5	**Mean**	**11.40**	**4.01**	**13.24**	**30.21**	**16.12**	**23.11**	**17.35**	**5**	**25.6**	**2227**	**303**	**35**
	SD	-	-	*0.34*	*0.78*	*1.17*	*2.00*	*2.91*	-	*4.7*	*390*	*4*	*1*
	Min	-	-	12.63	29.52	14.32	20.66	12.98	-	17.70	1531	296	47
	Max	-	-	13.63	31.53	17.82	25.47	21.11	-	31.5	2646	308	49
Solanum macrocarpon L *Fresh leaves* n=5	**Mean**	**12.03**	**5.82**	**15.42**	**35.41**	**13.40**	**13.18**	**6.07**	**5**	**29.5**	**2634**	**314**	**38**
	SD	-	-	*0.83*	*0.76*	*0.42*	*0.68*	*0.36*	-	*7.8*	*615*	*4*	*1*
	Min	-	-	13.98	34.70	12.97	12.09	5.42	-	21.8	2051	311	37
	Max	-	-	16.31	36.63	14.17	13.94	6.45	-	41.6	3572	321	39

Table 9 (continued): Composition of leaves and okra fruit from Benin.

Sample name		Dry matter content	Lipids	ADF fibers	Proteins	Ash	Iron	Zinc	IP6	beta-caroten	Vitamin A	Energy	
		%	g/100g DM					mg/ 100g DM			µg RAE/100g DM	Kcal/ 100g DM	Kcal/ 100g wet basis
Cassava	**Mean**	**19.71**	**<0.1**	**15.49**	**34.34**	**6.58**	**11.14**	**10.29**	**44**	**41.5**	**3614**	**312**	**62**
Fresh leaves	*SD*	-	-	*0.78*	*1.89*	*0.41*	*0.38*	*0.98*	-	*14.7*	*1272*	*4*	*1*
n=5	Min	-	-	14.51	30.86	5.80	10.67	9.17	-	30.0	2657	305	81
	Max	-	-	16.83	36.21	6.86	11.61	12.03	-	70.4	6104	319	85
Okra	**Mean**	**9.24**	**4.22**	**12.45**	**17.40**	**9.57**	**3.41**	**5.74**	**26**	**1.7**	**144**	**333**	**31**
Fresh fruit	*SD*	-	-	*1.61*	*2.51*	*0.73*	*0.55*	*0.73*	-	*2.2*	*184*	*7*	*1*
n=5	Min	-	-	10.90	14.59	8.47	2.83	4.97	-	<0.3	4	322	30
	Max	-	-	15.52	21.14	10.68	4.11	6.93	-	6.0	506	341	32
Vitex doniana	**Mean**	**8.33**	**2.13**	**32.08**	**24.90**	**4.49**	**27.65**	**3.88**	**11**	**23.7**	**4356**	**264**	**22**
Fresh leaves	*SD*	-	-	*3.16*	*1.46*	*0.37*	*8.89*	*0.43*	-	*3.8*	*652*	*13*	*1*
n=5	Min	-	-	26.67	23.43	3.87	15.89	3.37	-	16.7	3470	250	21
	Max	-	-	35.24	27.54	5.01	37.94	4.41	-	27.5	5403	286	24
Corchorus olitorius	**Mean**	**14.61**	**2.07**	**13.63**	**23.21**	**12.25**	**28.76**	**3.04**	**4**	**21.4**	**1836**	**307**	**45**
Fresh leaves	*SD*	*1.32*	-	*0.52*	*2.64*	*0.72*	*9.44*	*0.06*	-	*5.8*	*497*	*5*	*4*
n=3	Min	12.77	-	12.90	19.51	11.36	18.91	2.99	-	13.4	1147	302	40
	Max	15.80	-	14.06	25.50	13.13	41.48	3.12	-	26.8	2301	313	48
Launeae taraxacifolia	**Mean**	**9.68**	**2.80**	**11.93**	**24.61**	**12.42**	**9.99**	**2.43**	**9**	**37.9**	**1150**	**317**	**31**
	SD	*0.16*	-	*0.65*	*0.32*	*0.29*	*0.41*	*0.05*	-	*15.7*	*1465*	*4*	*1*
Fresh leaves	Min	9.52	-	11.44	24.25	12.15	9.42	2.39	-	20.3	44	311	30
n=3	Max	9.90	-	12.85	25.03	12.82	10.31	2.51	-	58.4	3220	319	32

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