Handbook on value addition on grain legume processing of soybean, cowpea, and groundnut for smallholder farmers in Borno State

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Cover photo: Plate 1 Women watching cheese cutting process. Plate 2 Soaked, cooked soybean seed. Plate 3 Fried soy and cowpea cake (Kosai). Plate 4 Soy kebab. Plate 5 Soymilk.

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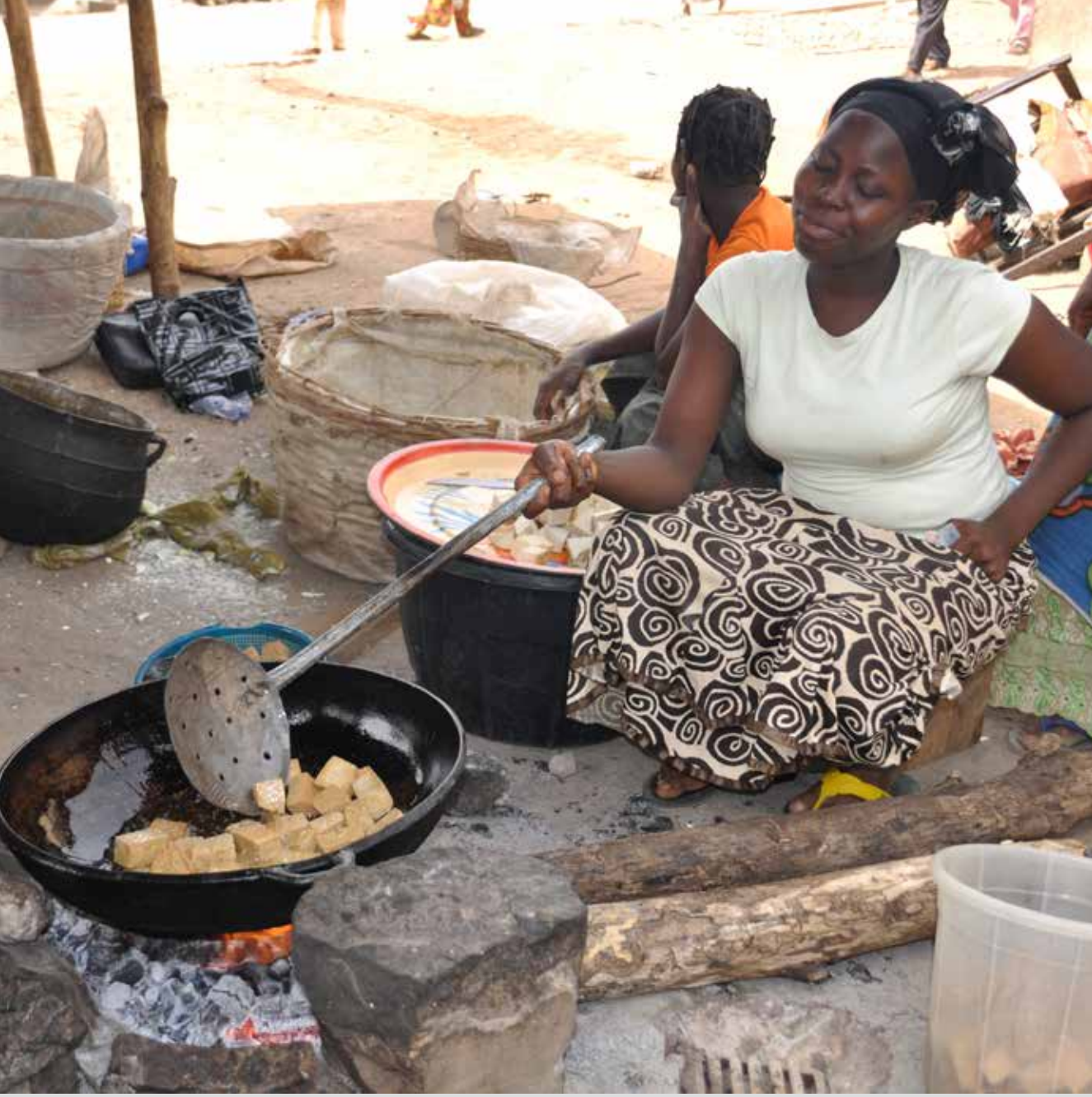

Nigerian woman processing soybean cakes

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Introduction

N2Africa is putting Nitrogen fixation to work for smallholder farmers in Africa through enhancing the yield of grain legumes and expanding the farm area cropped with legumes to improve income food and nutrition security. It is a large-scale, science-based, research-in-development project funded by the Bill &Melinda Gates Foundation with a vision of building a sustainable, long-term partnership to enable African smallholder farmers to benefit from symbiotic N-fixation by grain legumes through effective production technologies, including inoculants and fertilizers.

This project was being implemented in 11 countries including Nigeria. In Nigeria it is implemented Niger, Kaduna, Kano, Kwara, Benue, Sokoto, Kebbi, and Borno states and the FCT focusing on cowpea, groundnut, and soybean. The implementation of N2Africa Nigeria was coordinated by the International Institute of Tropical Agriculture (IITA).

Upon the request of the Borno State government in the context of an upcoming polio vaccination campaign, N2Africa was requested to explore strategies to expand its target area to Borno State, North eastern Nigeria. Borno State is one of the largest producers of cowpea, groundnut, and increasingly soybean in Nigeria. Agroecologically, Borno State includes the Sahel savanna, Sudan savanna, and northern and southern Guinea agroecological zones. The two latter agroecological zones are like those found in Kano, Kaduna, and Niger states, where N2Africa is involved in cowpea, groundnut, and soybean intensification.

N2Africa Borno works in four Local Government Areas (Bayo, Biu, Hawul, and Kwaya Kusar) with 40 communities in Borno.

Cowpea, groundnut, and soybean are gaining ground in the State due to their potential in fighting Striga and improving soil nutrients.

Most women derive their means of livelihood from processing activities in Borno State, therefore the knowledge and skills in grain legume processing and utilization will help the people in the State improve their nutritional intake and generate income from sales of the processed products.

Processing and preparation of grain legumes

The quality of food is of primary importance in determining consumer acceptance. Most raw foods must undergo some processing to attain a quality acceptable to

consumers. The processing of food for human consumption aims at improving the flavor, texture, and color and removing toxic substances. Legumes especially present problems that make their acceptance to consumers limited. Some of these problems include long cooking periods for grains, low digestibility of their protein and fiber, and deleterious biological factors some of which involve toxins in soybean.

Different recipes can be developed and prepared using cowpea, groundnut, and soybean for fortification of various dishes. Soybean can be prepared as drinks, snacks, meat, confectionary, baby weaning foods, and in fortification of cereals. Cowpea and groundnut can be also prepared whole, mixed, and in fortification of cereals.

This handbook contains recipes developed and prepared using cowpea, groundnut, and soybean.

Equipment used in recipe development are all locally available as listed below

1. Tablespoon
2. Teaspoon
3. Measuring bowl
4. Cup
5. Knife
6. Tray
7. Chopping board
8. Bucket
9. Basin
10. Wooden spoon

Production, importance, and consumption of grain legumes

Cowpea

Cowpea is a food and animal feed crop grown in the semi-arid tropics covering Africa, Asia, Europe, United States, and Central and South America. It originated from and was domesticated in southern Africa and was later carried to East and West Africa and Asia. The grain contains 25% protein and several vitamins and minerals. The plant tolerates drought, performs well in wide variety of soils, and being a legume, replenishes low fertility soil when the roots are left to decay. It is grown mainly by small-scale farmers in developing regions where it is often cultivated with other crops as it tolerates shade. It also grows and covers the ground quickly, preventing erosion.

The name “cowpea” was probably derived from when it was an important livestock feed for cows in the United States. Cowpea has high protein content. Its adaptability to different types of soil and intercropping systems, its resistance to drought, its ability to improve soil fertility and to prevent erosion makes it an important economic crop in many developing regions. The sale of the stems and leaves as animal feed during the dry season also provides vital income for farmers.

Cowpea is of importance to livelihoods of relatively poor people in less developed countries of tropics including south sudan, especially where animal protein is not easily available for the family. It is an important crop in the agriculture of African countries and south sudan in particular for the following reasons.

More than 5.4 million tons of dried cowpea is produced worldwide with Africa producing nearly 5.2 million tons. Nigeria, the largest producer and consumer, accounts for 61% of production in Africa and 58% worldwide. Africa exports and imports a negligible amount.

Harvesting

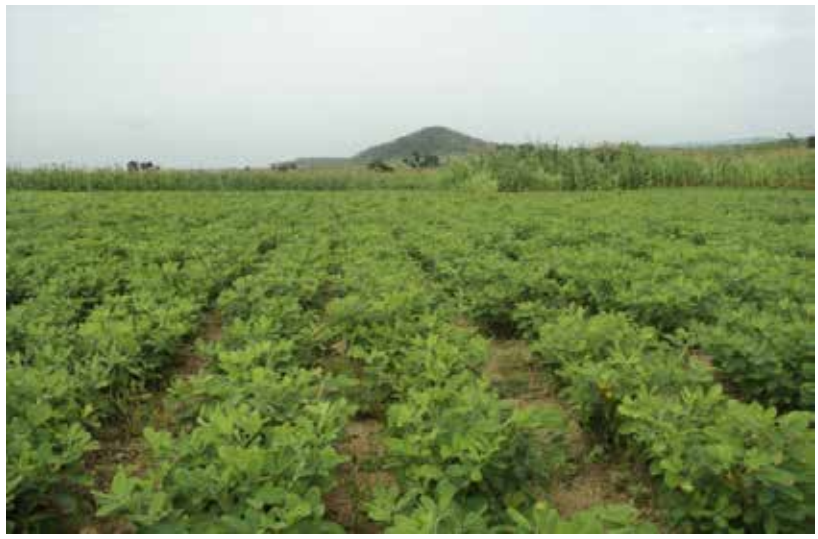
More than 11 million hectares of cowpea are harvested worldwide, 97% from Africa. Nigeria harvests 4.5 million hectares annually. The crops can be harvested in three stages; when the pods are young and green, mature and green, and mature and dry.

Consumption

All parts of the cowpea crop are used as all are rich in nutrients and fiber. In Africa, humans consume the young leaves, immature pods, immature seeds, and the mature dried seeds. The stems, leaves, and vines serve as animal feed and are often stored for use during the dry season. Fifty-two percent of Africa's production is used for food, 13% as animal feed, 10% for seeds, 9% for other uses, and 16% is wasted.

Regional preferences occur for seed size, color, and texture of seed coat. For example, Ghanaians are willing to pay a premium for black-eyed peas, while Cameroonians would lower their prices for them. More than 4 million tons of peas of all sorts are consumed worldwide, with 387,000 tons consumed in Africa.

Groundnut



Groundnut or peanut *(Arachis hypogea)* is a crop grown in the arid and semi-arid zone of Nigeria. It is either grown for its nuts, oil, or its vegetative residue(haulms). Recently the use of groundnut meal has become more recognized not only as a dietary supplement for children in protein-poor, cereals-based diets, but also as an effective treatment for children with protein-related malnutrition.

Groundnut is the 13th most important food crop of the world and the 4th most important source of edible oil. Its seed contain high quality edible oil (50%), it is an easily digestible protein (25%), and a carbohydrate (20%) (FAO 1994).The crop is mainly grown in the northern part of Nigeria; over 85% of the groundnut produced in the country is accounted for by Kano, Kaduna, Taraba, Bauchi, Borno, and Adamawa states (Abel and Harness 1978).

Importance

Groundnut sauce prepared with onions, garlic, peanut butter/paste with vegetables such as carrot, cabbage, and cauliflower (the peanut supplying ample protein) or prepared with meat, usually chicken. Groundnut is used in Mali meat stew “maafe”. In Ghana, groundnut butter is used for peanut butter soup “nkate nkwan”. Crushed ground nut may also be used for peanut candynkate cake and *Kuli Kuli,* as well as other local foods such as Oto. Groundnut butter is also an ingredient in Nigeria’s “African salad”. Groundnut powder is an important ingredient in spicy coating for kebabs in Nigeria and Ghana.

Production

Nigeria is the fourth largest producer of groundnut in the world and the highest producer in Africa with1.55 million tons. Groundnut grows best in light, sandy loam soil. It requires five months of warm weather, and an annual rainfall of 500 to 1000 mm or the equivalent in irrigation water.

The pods ripen from 120 to 150 days after the seeds are planted. If the crop is harvested too early, the pods will be unripe. If they are harvested late, the pods will snap off the stalk and will remain in the soil. They need an acidic to neutral soil to grow preferably with 5.9–7 pH. In tropical Africa, an average yield for groundnut is 300–1000 kg/ha; with good management practices and proper disease control, yields of up to 5 tons per hectare can be achieved.

Harvest

Harvesting usually consists of a series of operations comprising digging, lifting, winnowing, stocking, and threshing. Some of these tasks can be combined or eliminated depending on the system applied. Among the field operations concerned with groundnut cultivation, harvesting is the most laborious and costly. Harvesting should be done when the crop reaches physiological maturity, i.e., when a few leaves turn brown and the inner ribs of the groundnut are brown in color. All the pods will be recovered when pulled out of the soil.

Harvesting groundnut may sometimes become a problem especially when the crop has passed the stage of full maturity and the soil has hardened. An appreciable number of pods could be lost if care is not taken; this makes the harvest labor intensive.

Consumption

Groundnut is rich in protein, fat, and nutrients. In Africa and Nigeria, groundnut is consumed as candy when roasted, as fat when processed into oil, and as a snack when processed into cake *(kuli kuli).* The stem, leaves, and vines serve as animal feed and are often stored for use during the dry season.

Soybean

Soybean is a leguminous vegetable of the pea family that grows in tropical, sub-tropical, and temperate climates. Soybean was domesticated in the 11th Century BC around north-east China. It is believed that it might have been introduced to Africa in the 19th century by Chinese traders along the east coast of Africa.

Importance

Soybean consists of more than 36% protein, 30% carbohydrate, and excellent amounts of dietary fiber, vitamins and minerals. It also consists of 20% oil which makes it the most important crop for producing edible oil. Many leguminous crops provide some protein, but soybean is the only available crop that provides an inexpensive and high-quality source of protein comparable to meat, poultry, and eggs.

A by-product from the oil production (soybean cake) is used as a high-protein animal feed in many countries. Soybean also improves soil fertility by adding nitrogen from the atmosphere. This is a major benefit in African farming systems, where soils have become exhausted by the need to produce more food for increasing populations and where fertilizers are hardly available or too expensive for farmers.

Production

More than 216 million tons of soybean were produced worldwide in 2007 of which, 1.5 million tons were from Africa. Africa imports nearly as much soybean as it produces. Nigeria is the largest producer of soybean in sub-Saharan Africa (SSA) followed by South Africa. Low yields (less than one ton per hectare in tropical Africa) and a shortage of fertilizer constrain the ability of some countries to increase production. In Nigeria the haulms and the post-processed pulp (soybean meal) serves as important sources of animal feed. A 30% annual growth in the poultry industry, from 2003–2008 fueled such a demand for soybean meal that an increase in imports was required.

Commercial soybean production on large farms takes place in Zambia, Zimbabwe, and South Africa. However, it is mostly cultivated by small-scale farmers in other parts of Africa where it is planted as a minor food crop among sorghum, maize or cassava.

Harvesting

Nearly 95 million hectares of soybean were harvested worldwide in 2007, with 19 million in Asia, 3.5 in the United States, and 1.2 in Africa. Depending on the variety, soybean can be harvested between 100 and 150 days after planting. Labor requirements in Africa are high since most cultivation and harvesting are done manually.

Consumption

Consumption of soybean is 11 million tons worldwide. Africa consumes about 618,000 tons annually, and uses 4800 tons for animal feed. Nigeria is the largest consumer of soybean in SSA followed by Uganda. In Africa, dry soybean is used to produce milk substitutes and flour. The bean curd is fried and eaten as a snack or breakfast food. Mature beans are not easily digested and contain toxic compounds which require soaking and prolonged cooking.

Grain legume nutritional value

Legume foods not only offer excellent sources of protein and carbohydrates, but also fat with varying concentrations in each legume. They also provide rich minerals and vitamins. The leaves and the pod have high concentrations of essential nutrients. Legumes also contain significant fiber, potassium, iron, sodium, and other B complex vitamins.

Legume	Edible part	Protein%	Fat %	Carbo-hydrate %	Ca mg/100	P mg/100	Vit A	Vit C	Thiamin mg/100
Cowpea	Seed	28	2	69	124	432	11	1	1.7
	Leaf	36	3	50	664	964		327	3.18
	Post	33	5	55	478	522	4027	212	1.24
Groundnut	Seed	25	48	8	52	438	16	1	0.34
Soybean	seed	39	22	36	245	608	11	0	0.73
	sprout	14	10	43	251	580	11	0	0.74

Grain legume (cowpea, groundnut, and soybean) recipe development

Soybean flour preparation

Remove stones and dirt from soybean

↓

Wash and soak soybean for 30 minutes

↓

Dehusk soybean and wash off the husk

↓

Wash soybean and spread to dry

↓

Grind into powder, sieve, and keep in a closed container for use

The prepared flour can be used to fortify other cereals like sorghum, millet, or maize in the preparation meals like of tuwo, pap, and snacks.

Community and school cereal legume recipe development demonstrations sessions.

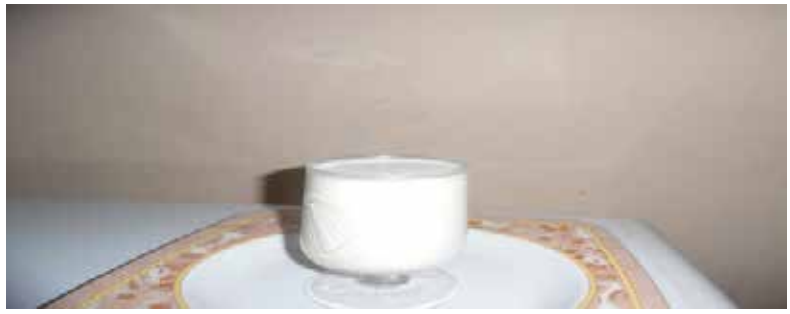
Soymilk

Ingredients

- Soybean - 6 cups
- Water - 1 gallon
- Sugar - to taste
- Salt - tablespoon

Method

1. Clean soybean by removing foreign matter
2. Soak in water for 8–10 hours and wash
3. Add water and boil for 20 minutes
4. Drain water and wash without dehulling
5. Grind beans into a very smooth paste
6. Strain the mixture through a muslin cloth to extract milk
7. Cook the milk by boiling for 10 minutes, add sugar, salt, and flavouring
8. Serve chilled or warm



Processed Soybean Milk.

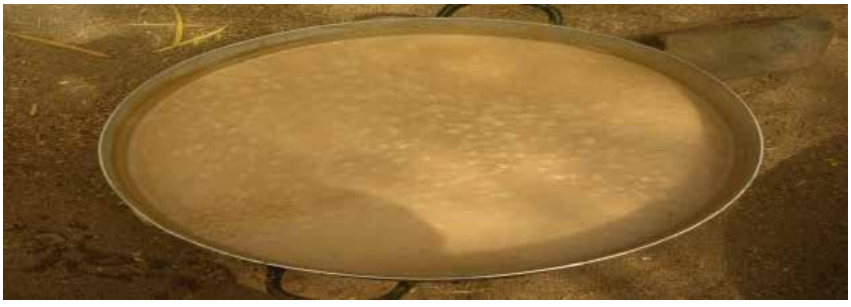
Tom Brown (weaning feed)

Ingredients

- Soybean - 1 cup
- Sorghum - 4 cups
- Groundnut - ½ cup
- Sugar - to taste

Method

1. Roast sorghum, soybean, and groundnut separately in a hot pan
2. Dehull roasted soybean and groundnut
3. Mix roasted sorghum, soybean, and groundnut into a ratio of 4:1:1/2
4. Dry mill into powder and sieve into fine flour
5. To prepare for consumption, mix in water and bring to boil while stirring continuously
6. Allow to boil for 5 to 10 minutes
7. Serve



Tom Brown.

Tom brown is the term used in describing weaning food, when the baby makes a gradual transition from breast milk alone to eating a wide range of food.

The weaning period is a crucial time in a child's life: it is the time when children are most likely to become malnourished if they do not learn to take mixtures of many foods.

Soy Cheese

Ingredients

- Soybean - 10 cups
- Tamarind/lime - medium size cup
- Water - 2 gallons

Method

1. Soak soybeans in excess water for 8–10 hours
2. Drain soaked water and wash but not dehull
3. Wet mill into a paste
4. Add water to mix
5. Sieve through a fine cloth or sieve
6. Pour milk in a pot and heat on fire to boil, add coagulant (tamarind) and stir
7. Allow to boil until coagulated
8. Scoop coagulated milk into a cheese board lined with cheesecloth into the cheese bag
9. Fold the sides of the cloth over the coagulated milk and put weight on it for 30 minutes to squeeze out excess water and make the curd firm you can use the curd to make kebabs, scrambled cheese, and awara

Soybean Cheese (basic product)

Kebab

Ingredients

- Cheese - Flattened in crate
- Pepper - 4 medium sizes
- Onions - 1 medium size
- Maggi cubes - 3 cubes
- Oil - 3 tablespoons

Method

1. Cut soy cheese into cubes

2. Slice onions and pepper; arrange the cheese and the sliced vegetables

3. Drop the cheese pieces into water/seasoning/salt solution

4. Remove the pieces and deep fry till golden brown

5. Serve as snacks

Soy Kebab

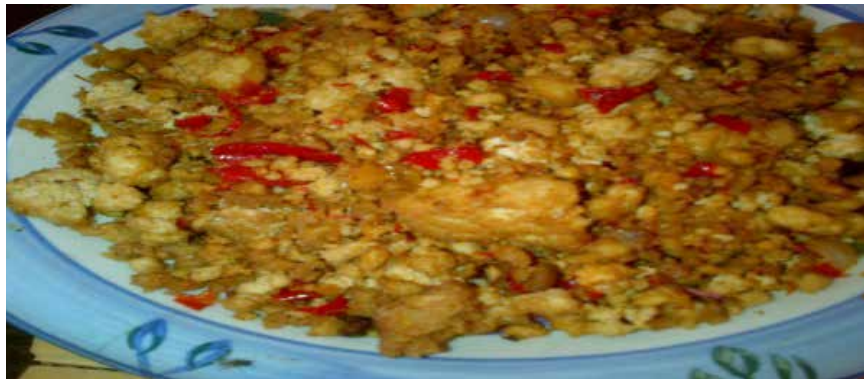
Soy Omelet

Ingredients

- Soy cheese - 4 strips
- Onion - 1 medium size
- Tomatoes - 2 medium size
- G/nut oil - 3 tablespoons
- Salt/maggi - 2 cubes

Method

1. Chop soy cheese, pepper, onion, and tomatoes and put into bowl
2. Add salt and Maggi to taste
3. Mix well
4. Fry in oil and serve



Soy Omelet

Cowpea cake (Akara)

Ingredients

- Cowpea - 2–3 Cups
- Soybean -1/2 cup
- Salt - to taste
- Onions - 1 large
- Pepper - 5 large sizes
- Oil - 2 liters

Method

1. Soak beans in water for 5–10 minutes. Soak soybeans for 1 hour and boil for 20 minutes
2. Wash and dehull soybean and cowpea
3. Mix dehulled soybean and cowpea, add sliced onions and pepper
4. Grind beans into a smooth paste
5. Add a little water, add salt to taste
6. Heat oil and fry by scooping the paste with spoon to desired quantity. Fry until brown and serve

Soybean/cowpea cake (Akara)

Soybean Vegetable Soup

Ingredients

- Meat/Fish (optional)
- Soybean residue from milk
- Leafy vegetables - 2 bunches
- Palm oil - ½ cup
- Vegetables (tomato, pepper, onion)
- Water - 10 Cups
- Maggi - 3 Cubes
- Spinach - 2bunches

Method

1. Wash and boil meat or wash fish
2. Wash and cut leafy vegetables
3. Fry onion, pepper, and tomato
4. Add boiled meat or fish and fry till golden brown
5. Add water and allow meat to cook
6. Add soybean residue, Maggi, and salt
7. Allow to cook until the consistency is thick
8. Add the leafy vegetables and cook for 10 mins
9. Remove from heat and serve with tuwo

Soybean Vegetable Soup.

Groundnut cake *(Kulikuli)* **and oil**

Ingredients

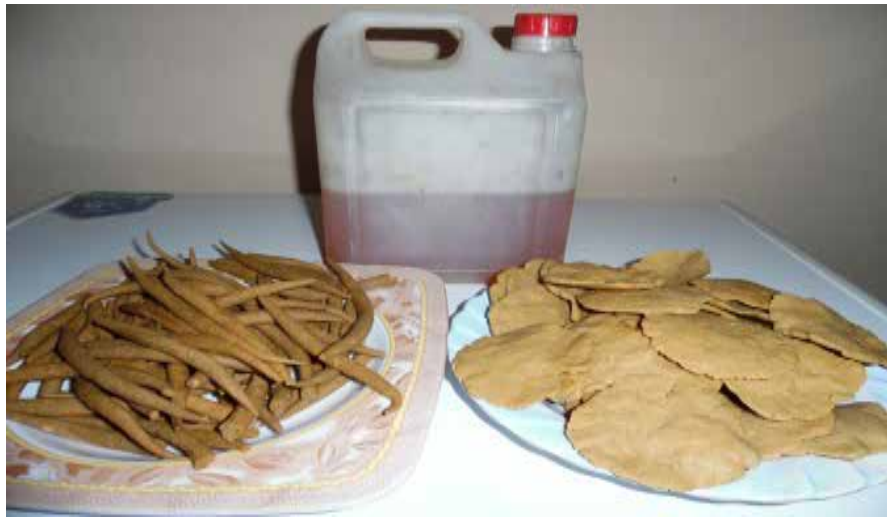
- Groundnut -10 cups
- Water - 1 liter
- Salt and spice - to taste

Method

1. Remove stone and dirt from groundnut
2. Fry to golden brown and dehusk
3. Grind into a paste
4. Pour the paste into a pot or mortar
5. Add warm water and stir continuously
6. Add more water as you continue to stir until oil begins to rise to the top
7. Remove oil from the cake as you stir the paste until the oil is completely removed and the paste firm
8. Mold the cake into desired shape and size
9. Deep fry using the extracted oil from the groundnut

Manual processing of groundnut oil.

Molded groundnut cake ready for frying.



Processed groundnut cake and oil.

Glossary

Awara: Another term for cheese

Carbohydrate: Substance found in plants and animals including cellulose starch, sugar that supply energy

Deficiency: State of not having enough or nutritional insufficiency of one or more elements in diet such as iron or vitamins

Grain Legume: An annual crop producing edible seed in legume family (cowpea, groundnut, and soybean) on which N2Africa is working on

Kunun Gyada: Pap made of ground nut milk using rice, millet, or sorghum

Malnutrition: Condition of health created by Lack of food or the right food

N2Africa: Is the short form of the project “Putting Nitrogen fixation to work for smallholder farmers in Africa”

Protein: Nitrogen bearing molecules containing amino acids essential for building and maintaining muscles and internal organs

Protein deficiency: The state of not having enough protein

Pottage: Heavy stew thickened with boiled legume or carbohydrate

Tuwo: General term for thickened carbohydrate foods prepared by overcooking grain such as rice, or flour from millet or sorghum.

Spinach: Edible leafy greens

Women empowerment: Women gaining power and control over their lives. It involves awareness raising, building self-confidence, expansion of choice, increased access to and control over resources, and action to transform the structures and institutions which reinforce and perpetuate discrimination and inequality.

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About the handbook

Women empowerment through grain legume entrepreneurship is a project objective of N2Africa. This is achieved by increased women's participation in project activities, ranging from diagnostic demonstration, adaptation as well as seed production. With this level of participation, women are also being trained on productive skills in grain legume processing for improved household nutrition and value addition on a yearly basis. The handbook focuses on legume processing with an emphasis on soybean for home makers as well as means of improving household nutrition and for cottage industry processing. The handbook will be distributed during farmers' field days, end of season evaluation, and during nutrition campaign as part of nutrition packages of extension service delivery to rural families, partners, farmers, and home economic agents.

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