FOOD RESEARCH INSTITUTE

ANNUAL PROJECT REPORT

Charlotte Oduro-Yeboah, Mariam Tandoh-Wordey, Jolene Nyako and Mary Obodai

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Summary

This annual report the activities performed by CSIR-Food Research Institute under the upscaling Millet sourdough technology in West Africa (MBOSS) for February 2018 to September, 2018. The report gives the breakdown of survey work, inception workshop, steps undertaken for acquisition of Twin screw extruder, millet sourdough bread trails, consumer acceptability of millet sour dough. The progress of three Master of philosophy students' thesis is also presented in this report.

Introduction

Pearl millet (*Pennisetum glaucum*) is one of the important crops in semi-arid areas of Africa and India. Pearl millet crop has a wide adaptability to local environments for its properties of being tolerant to drought and heat. For this reason, it is widely grown in tropical regions of the world including Africa and Asia. Pearl millet is currently the world's sixth most important cereal grain and is grown extensively in Africa, Asia, India and the Near East as a food grain and is the staple source of nutrition for millions of people. India is the largest producer of pearl millet, both in terms of area and production (Yadav and Rai, 2013).

Millet (*Pennisetum glaucum* (L.) is a small cereal with seeds of 1.2-1.8 mm in diameter and a light brown-to-brick red colored seed coat with an undulated surface. Millet is a word derived from "mille", which signifies a thousand grains. The major millet species in the world is pearl millet (Pennisetum glaucum (L.), followed by foxtail, proso and finger millet (Shahidi & Chandrasekara, 2013). Pearl millet is a food that supplies a major proportion of calories and protein to large segments of populations in the semi-arid tropical regions of Africa and Asia (O'Kennedy *0*., 2006). Millet is a gluten-free and low-cost cereal (approximately 40% lower than the price of corn), which is resistant to drought and nutrient-poor soils (Gomes *et al*., 2008). In 2011, the global millet production was about 27.5 million tonnes (Food and Agriculture Organization, 2015). Countries in Africa and Asia produced 56% and 41% of the total world production, respectively (Shahidi & Chandrasekara, 2013).
Millet is a gluten-free and low-cost cereal (approximately 40% lower than the price of corn), which is resistant to drought and nutrient-poor soils (Gomes *et al*., 2008). In 2011, the global millet production was about 27.5 million tonnes (Food and Agriculture Organization, 2015). Countries in Africa and Asia produced 56% and 41% of the total world production, respectively (Shahidi & Chandrasekara, 2013).

World -wide bread consumption accounts for one of the largest consumed foodstuffs, with over 20 billion pounds (9 billion kg) of bread being produced annually. This demand has been driven by consumers' seeking convenient fresh products that provide a source of nutritional value (Hebeda & Zobel, 1996). Consequently, freshness is a key component in consumer acceptability and choice of bread. However, the freshness perception is not easily described, particularly as it is likely to vary from one bread type to another.

Bread is an important staple food in both developed and developing countries. Worldwide bread consumption accounts to be one of the largest consumed foodstuffs, with over 9 billion kg of bread being produced annually. This demand has been driven by consumers seeking convenient fresh products that provide a source of nutritional value (Hebeda and Zobel, 1996).

Bread, the major bakery product of cereal grain, is a staple food in several cultures (Malomo *et al*., 2011). It is so important in human diet that increases in its price have triggered off angry protests in some countries where up to 50% of their total calories are supplied by bread alone (Pomeranz and Clifton, 1996; Akobundu, 2006).

Akobundu (2006) reported that in Nigeria, there is increasing population and cravings for fast and convenience foods now, bread consumption in the society has greatly increased.

Bread, a steady and important staple food in Nigeria with increasing consumption rate, is however, relatively expensive according to the reports of Edema *et al*. (2005) and Olaoye *et al*. (2006). This is because the major raw material in bread making, wheat, is an imported and temperate cereal crop, which may not grow in the tropics due to climatic reasons. With the increase in the bread consumption in Ghana, efforts have now been made to promote the use of composite flours in which flours from root crops and cereals which are locally grown crops were partially substituted into wheat flour for bread making. This composite flour programme would thereby minimize the demand for imported wheat; produce protein- enriched bread (Giami *et al*., 2004; Olaoye *et al*., 2006); conserve foreign reserves (Eddy *et al*., 2007) and widen the utilization of indigenous crops in food formulation (AdeOmowaye *et al*.,2008).

Reports have been published on the successful composite bread technology (though such bread still require at least 70% wheat flour to be able to rise) using some indigenous crops like soybeans, plantain, cocoyam, sweet potato, breadfruit, breadnut etc (Oluwole *et al*., 2005; Onuh and Egwujeh, 2005; Olaoye *et al*. 2006; Eddy *et al*., 2007; Ade-Omowaye *et al*., 2008; Malomo, 2010; Malomo *et al*., 2011).

Due to its nutritional characteristics and low cost, there is increased interest in millet due to its health benefits, hypoglycemic characteristics (Lakshmi Kumari and Sumathi, 2002) and due to the antimicrobial and antioxidant activities of its polyphenols (Chethan and Malleshi, 2007). Moreover, as millet does not contain gluten and is known for its low carbohydrate concentration and low glycemic index (Singh *et al*., 2010; Suma and Urooj, 2014), some authors has studied its viability in bakery products such as breads, biscuits and pasta (Rathi *et al*., 2004; Saha *et al*., 2011; Schoenlechner *et al*., 2013), aiming to replace whole-wheat flour with millet flour. The acceptability of the foods developed with millet flour, such as biscuit dough and breads, is reported to be very good (Saha *et al*., 2011; Schoenlechner *et al*., 2013).

Fermentation is known to improve the nutritional value of raw materials and by using fermented foods in the diet; the nutritional status of the individual can be improved (Motarjemi and Nout, 1996). Other studies on nutritional changes in fermented millet have found improvement of the *in vitro* protein digestibility (Antony and Chandra, 1998; Ali *et al*., 2003) and a significant reduction in total polyphenols and phytic acid content (Obizoba and Atii, 1994; Sharma and Kapoor, 1996; Antony and Chandra, 1998; Elyas *et al*., 2002; Tou *et al*., 2006). The effects of fermentation on tannins are variable. A reduction was reported by Antony and Chandra (1998) and no reduction in tannin content was reported by Elyas *et al*. (2002). Furthermore, an increase in starch digestibility (Antony and Chandra, 1998), increase in total free amino acids (Antony and Chandra, 1997), increase in minerals (Antony and Chandra, 1998), and a reduction in trypsin inhibitor activity (Antony and Chandra, 1998) have been found when fermenting millet.

Sourdough fermentation is a type of solid state fermentation used in preparation of some food products. The process is a useful tool for adding value to locally available agriculture produce as well as foster cultural and geographical distinctiveness. Sourdough fermentation impacts unique characteristics on ground cereals or starchy raw materials; this includes making them available in different forms, improving the nutritional properties of cereal, food preservation through lactic acid, reduction of toxins foods, enhancing a range of flavors, odor and textures of food and so on (De Vuyst and Neysens, 2005; Chavan and Chavan 2011; Karrar, 2016). Sourdoughs are used worldwide for a huge variety of products: leavened bread, fermented gruels, alcoholic and/or acid fermented drinks, vinegar and fermented rice (Hammes *et al*., 2005; Achi and Ukwuru, 2015 and Adinsi *et al*., 2014).

Today, sourdough is used in the industry of breads, cakes, and flakes (Thiele *et al*., 2002; Chavan and Chavan 2011). Use of sourdough in breads has acquired popularity as a mean to improve the quality, flavor and shelf life of breads. French breads, Italian, Panetone and soda crackers are also examples of wheat products that rely on the process of souring. Conventional bread dough fermentation increases elasticity and viscosity, whereas the addition of sourdough to final bread dough results in decreases elasticity and yields softer dough (Chavan and Chavan 2011).

Fermentation of foods has been practiced for improving the flavour, texture and palatability of foods.

Pearl millet has a high nutrient content but bioavailability is low, inherently due to the presence of ant nutritional factors, such as phytic acid, polyphenols and tannins (Onuoha *et al*., 2017).

Fermentation is one of the processes known to reduce these anti-nutrients. The changes associated with the fermentation process are as a result of action of enzymes produced by microorganisms.

Lactic acid bacteria (LAB) are commonly involved in the fermentation of carbohydrate based substrates (Onuoha *et al*., 2017).

In lactic acid fermented foods, the acidity is usually below pH 4.5. Most pathogenic microorganisms found in food cannot survive at this low pH, hence, lactic acid fermentation of food has been found to reduce the risk of growth of pathogenic microorganisms in the food.

The probiotic bacteria are found to be developed in the spontaneously fermented pearl millet (Ranasalva and Visvanathan, 2014).

Bakery products are used as a vehicle for incorporation of different nutritionally rich ingredients. Fortification of wheat flour with non-wheat proteins increases protein quality by improving its amino acid profiles. Studies by (Ranasalva and Visvanathan, 2014), showed that anti nutrients phytic acid was reduced from 858.4 mg/100 g in the raw pearl millet to 380.3 mg/100 g in the cooked fermented pearl millet. The cooked fermented pearl millet was utilized for the production of bread and cookies substituting refined wheat flour. The bread substituted with 10, 15 and 20% of the cooked fermented pearl millet flour showed good textural and physical properties and the quality was comparable to the market bread. Cookies were prepared from the 50 and 100% replacement of wheat flour and the cookie with 50% cooked fermented pearl millet flour showed good acceptability.

In West Africa, bread is consumed by many people daily and the current global increase in celiac disease attributed to the consumption of 100% wheat bread has resulted in the advocacy for the use of composite flour for bread production. A 100% wheat bread is expensive as wheat is usually imported at high exchange rates. Past efforts to promote the use of composite flour was in using high quality cassava flour (HQCF). This did not solve the problem as imported wheat forms 90% of the composite flour used. Selected West African countries are however blessed with many agricultural commodities such as millet with potential for use in baking. Millet is commonly processed into flour for making traditional thick and thin porridges, steam-cooked products like couscous, and both non-alcoholic & alcoholic beverages. They have not been widely used in bread making and extruded snacks because they lack the structure-forming protein, gluten, present only in wheat. However, the use of sourdough technique is known to improve the baking potential of non-wheat flours as demonstrated in the previous Africa-Brazil project implemented by the team. In addition, sourdough bread made from whole grain, non-wheat cereals have been confirmed to exert greater benefits beyond basic nutrition. Development of novel products such as millet sourdoughs bread and extruded products will provide some economic benefits for the countries and increase the utilization of millet which is presently underutilized. Thereby increasing its cultivation by smallholder farmers and this will increase their income and livelihood. The sourdough and extrusion technologies are particularly important for obtaining processed foods that are stable to temperature variation and safe of microorganisms. These processed products are also easy to store with no need of refrigeration and having an improved shelf-life when compared to conventional loaves. These techniques can be adopted by inhabitants of rural communities, community based women groups, small and medium enterprises, and processors.

Previous marketplace helped in creating a platform for the use of sourdough and extrusion techniques in utilization of whole millet grain. In addition, sourdough bread made from wholegrain millet was confirmed to exert greater benefits beyond basic nutrition. The millet sourdough bread contains Lactic Acid Bacteria (LAB) that ferments the millet flour/water mixture and creates lactic acid, a catalyst that greatly increases the micro-nutrient profile of the bread, which makes digestion of the starch easier in the body. The interesting advantage of millet extrusion would benefit the growing market of ready-to-eat snacks and easy-to-prepare flours for wheat flour replacement.

2.0 Objectives of the project

1. To develop and promote commercializable novel millet sourdough products using baking and extrusion technology adaptable to West African production.
2. To determine the effect of consumption of millet sourdough bread and extruded snacks on the nutritional and health status of school children in selected West Africa countries.
3. To determine the shelf-life of millet sour dough bread and extruded snacks during storage.
4. To assess the prevalence of celiac disease in the selected countries.
5. To build capacity and promote training of bakers, SMEs and other beneficiares.
6. To assess economic viability of the transferred millet sour dough and extrusion technology for value addition to whole grain millet.

3.0 Activities carried out within the period

3.1 Meetings held at CSIR-Food Research Institute

The CSIR-FRI team members held meetings on the 19th January, 2018 and 26th February, 2018 respectively to plan on the execution of the work packages of the project.

3.2 Survey Work

As part of activities carried out at CSIR-FRI a survey was conducted to gather information on existing baking technologies, existing millet products and millet extruded products. This was done by administering questionnaires for millet producers (Figure 1), Traders (Figure 2), SMEs processors (Figures 3&4) and consumers (Figure 5). These questionnaires were designed by the Nigerian team and edited to suit the Ghanaian environment. The questionnaires were pre-tested using 20 Pearl millet Farmers from Manga in the Upper East Region of Ghana, 20 millet processors, 20 millet Traders, 20 SMEs and 30 millet consumers from the Greater Accra Region of Ghana. A total of 110 actors were used for the pretesting. The questionnaires were modified per the suggestions obtained from the pre-testing survey.

The modified questionnaires were used for the actual survey which was held in both the Northern and Greater Accra Regions.

The breakdown of the random sampling in the two locations are shown in Table 1.

Table 1: Random sampling of Actors used in the survey work

Actors	**Northern Ghana**	**Greater Accra**	**Total**
Pearl Millet Farmers	200	-	200
Processor	50	50	100
Traders	40	40	80
Consumers	100	100	200
SMEs	-	50	50
Total	390	240	630

Figure 1: Questionnaire being administered to a Pearl Millet Farmer at the Central zone of the Upper East Region of Ghana.

Figure 2: Figure 2: Pearl millet Traders being interviewed at Central zone of the Upper East Region of Ghana

Figure 3: Questionnaire being administered to a processor at Upper East region of Ghana

Figure 4: Questionnaire being administered to a processor at Greater Accra and its environs

Figure 5: A Pearl millet consumer being interviewed at Central zone of the Upper East Region of Ghana

3.2.1 Locations

The location in the Upper East region- Manga where the survey work was conducted were the Western Zone which consisted of Kassena Nankana West, Kassena Nankana East, Builsa South and Bulisa North, for the Central zone, the following districts were considered Bolga Municipal, Bongo, Talensi and Nabdam areas. The Greater Accra and its environs were also surveyed. The questionnaires will be analyzed and a report prepared.

3.3 Inception Workshop

An inception workshop was held from the 5^{th}-9^{th} March, 2018 at the Federal University of Agriculture, Abeokuta (FUNAAB), Nigeria. Program of workshop (Appendix I). A five member delegation consisting of project team members and Masters' students attended the workshop. The members were Dr. (Mrs) Charlotte Oduro-Yeboah and Mrs. Marian Tandoh - Wordey while the students were Mrs. Edna Mireku-Essel, Mr. Michael Amoo-Gyasi and Mrs. Dorothy Narh. There were presentations on the status of the project in Ghana and the students presented their proposals.

Students' proposal presentations

The following were the project proposal topics

- Formulation and Promotion of Pearl Millet Sourdough Extruded Snack Food for School Children in Ghana (Mrs Edna Mireku-Essel)
- Mycotoxicological Characteristics of millet grains and products along the millet value chain (Mrs Dorothy Narh)
- Development of starter culture for the fermentation of pearl millet into sourdough for the production of bread and extruded snack products in Ghana (Mr Micheal Amoo-Gyasi)

3.4 Purchase of 200-250kg/h Extruder drying snack production line

A team of project members from Ghana, Nigeria and Benin travelled to China, Jinan from the 31st March 2018 to 7th April, 2018 to inspect the operations of the Twin Screw Extruder before purchasing and shipping to the various countries. The two companies visited were Jinan Arrow Machinery co. Ltd (Figure 6) and Jinan Keysong Machinery co. Ltd (Figure 7). The 200-250kg/h Extrusion line consists of a mixer, screw conveyor, KS-70 double screw extruder matched with 5 different dies of different shapes, screw conveyor, an electric dryer with 5 layers 5 meters, a flavouring system and a semi-automated packaging machine (Figures 8&9). The team (Figures 10&11) agreed to add a milling machine and a cabinet dryer to the line. Figure 12 shows pictures of extruded snacks.

Figure 6: Frontage of Jinan Arrow Machinery co. Ltd

Figure 7: Frontage of Jinan Keysong Machinery Co. Ltd

Figure 8: Front view of the Twin-screw Extruder

Figure 9: Picture showing the control board of the twin screw extruder

Figure 10: Benin and Ghanaian members in front of the Jinan Arrow Machinery Co. Ltd

Figure 11: MBOSS Millet sour dough project Team members exhibiting the extruded product

Figure 12: Samples of extruded products using different dies

FUN TIME

Figure 13: Team members taking supper at KFC, Jinan, China

Figure 14: Project team members with Keysong machinery management taking lunch at Chinese Restaurant

3.5 Pearl Millet Fermentation Experiments

Various experiments were carried out to determine the vitamin and mineral levels of fermented Pearl millet samples. The aim of these experiments was to ascertain whether the developed Pearl millet sour dough flour has the same minerals and vitamin contents as the fermented grain flour.

3.5.1 Methodology

Pearl millet samples (5kg) were weighed, sorted, washed thoroughly and soaked for 24h, 36h and 48h. The soaked samples were dried in an Apex dryer (U.S.A) at a temperature of 55°C for 4 hours. Dried samples were milled using laboratory mill and stored in air-tight polythene. Pictures of the experiments are shown in Figures 15-24. Moisture and pH of the samples were determined. A control sample was prepared by sorting the millet samples, washing, drying and milling. The minerals (Iron, phosphorus and calcium) and vitamin A and C will be determined for the four (4) samples.

4.0 Way forward

- The administered questionnaires will be collated and analyzed.
- Trials will be conducted for Pearl millet sour dough protocol developed under 'Nutritional properties and health functionality of wholegrain millet sourdoughs' project in Nigeria.
- The Millet sour dough formulations will be used for the production of the Pearl millet sour dough bread.
- Purchasing and installation of the Twin screw Extruder for the extruded sour dough products
- Students will continue with their project works

5.0 Activities carried out within the second quarter (May-July, 2018)

5.1 Survey Work

The questionnaires are being collated and analyzed for writing a report on the survey

5.2. TRIALS ON MILLET SOURDOUGH BREAD

Materials used were two varieties of Pearl millet grains samples namely Early and Late Pearl millet.

Millet sour dough was prepared using the procedure below:

Pearl MILLET

↓

SORT

↓

WASH (3 times)

↓

DRY MILLET

↓

MILL

↓

MILLET FLOUR (CHECK MOISTURE)

↓

ADD WATER (1:1)

↓

FERMENT FOR 48 HOURS

↓

MILLET SOUR DOUGH

Figure 15: Protocol for production of pearl millet sourdough

5.3 Procedures/Methods for millet sourdough preparation trials

Table 2: Ingredients and weight used for Millet sour dough preparation

Ingredients	Weight (g)
1. Millet Sourdough	240
2. Wheat flour	360
3. Water	180
4. sugar	20
5. Salt	10
6. Margarine	20
7. Nutmeg	0.1
8. Vanilla essence	2.5 mL

Weight ingredients

↓

Sieve wheat flour

↓

Add sour dough to wheat flour (Depending on proportions)

↓

Mix thoroughly to form a dough

↓

Knead dough for 15mins until smooth

↓

Cut into desirable sizes and mold into well-greased baking pans

↓

Cover with clean cloth and allow it to proof (3-4h)

↓

Bake in a moderately hot oven set at 170°C for 35-45min.

↓

Remove, allow to cool and bag in polythene.

Figure 16: Methods for preparation of millet sourdough bread

Table 3: Millet sour dough bread formulation prepared

Formulation	Millet sour dough	Wheat flour
1. 90%	90	10
2. 80%	80	20
3. 70%	70	30
4. 60%	60	40
5. 50%	50	50
6. 40%	40	60
7. 30%	30	70
8. 20%	20	80
9. 10%	10	90

NB: the more sourdough, the lesser water used

Figure 17: Sorting of Pearl millet grains

Figure 18: Sorted Pearl millet grains

Figure 19: Washing of Pearl millet grains

Figure 20: Decanting washing water

Figure 21: Straining of washed Pearl millet grains

Figure 22: Drying of washed Pearl millet grains at 50°C

Figure 23: Dried Pearl millet grains

Figure 24 : Pearl Milled millet flour

Figure 25: Pearl millet dough bread

Figure 26: Pearl millet dough bread

Figure 27: Late Pearl millet sourdough bread

Figure 28: Early Pearl millet sourdough bread

Figure 29: Late Pearl millet (100%) sourdough bread

Figure 30: Late Pearl millet (50%) sourdough bread:50% wheat flour

Figure 31: Baking of millet sourdough bread from different formulations

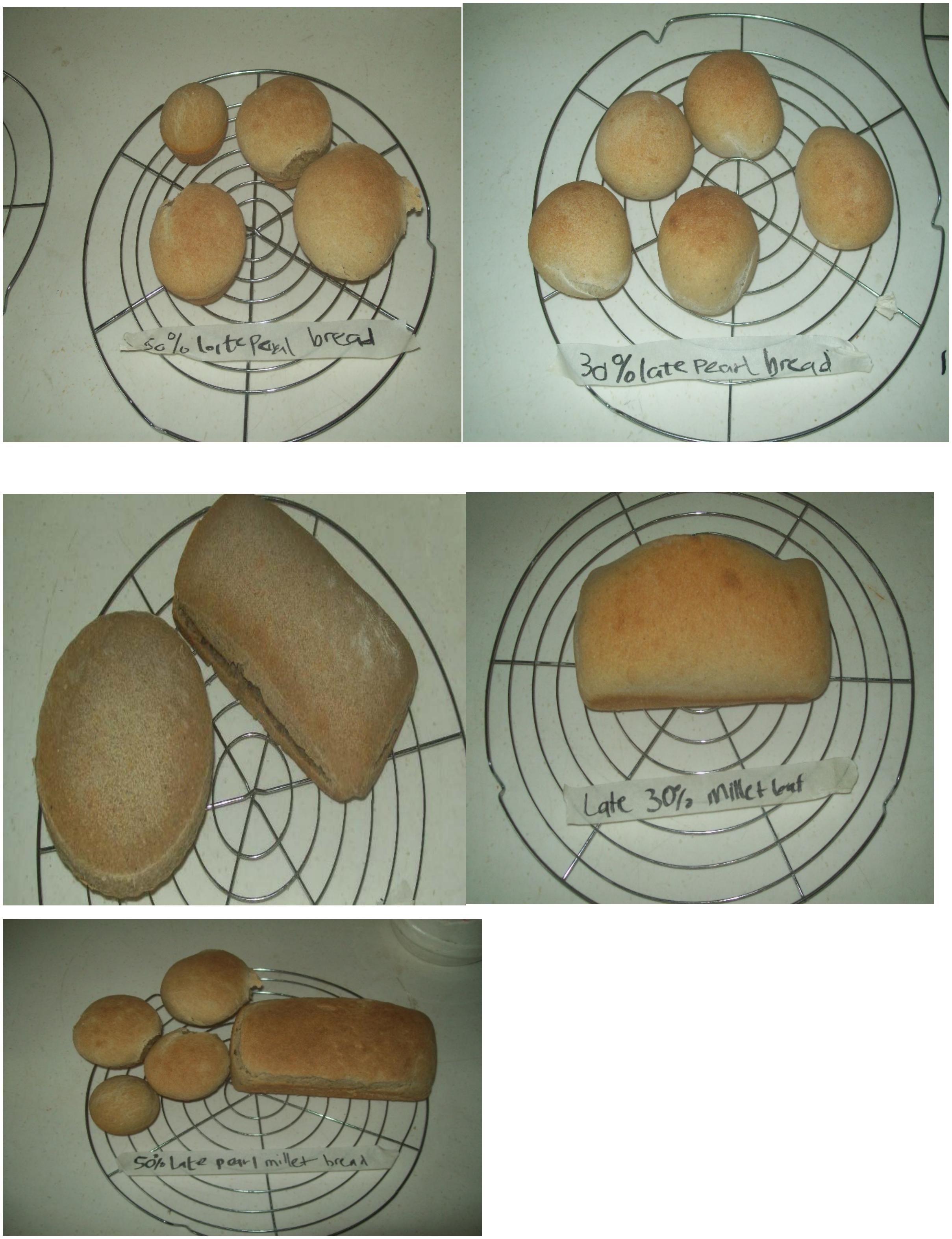


Figure 32: Baked millet sour dough bread of varying proportions of millet sour dough and wheat flour

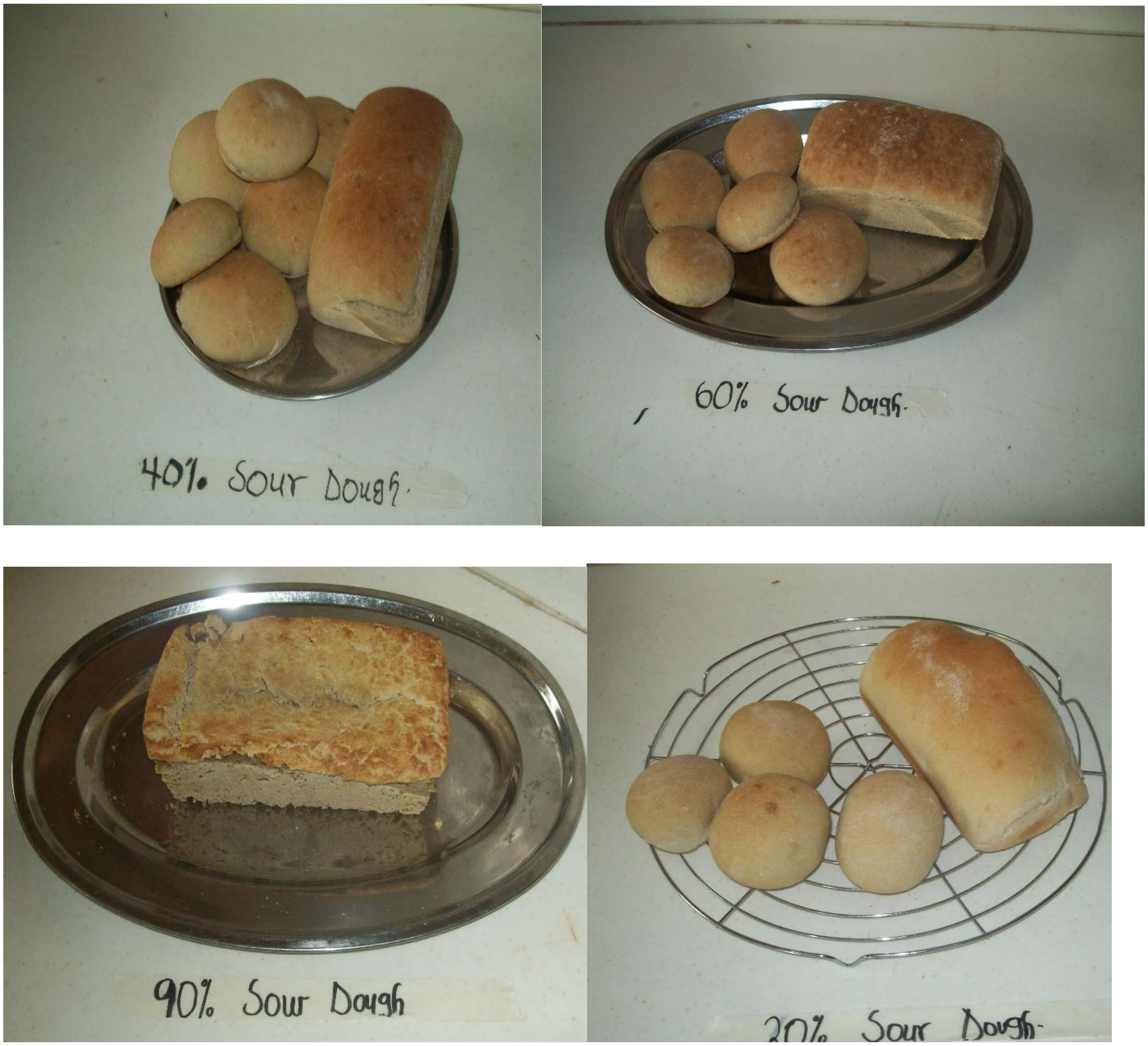


Figure 33: Baked millet sour dough bread of varying proportions (40%, 60%, 90%, and 30%) of millet sour dough and wheat flour

Figure 34: Baked millet sour dough bread with (70% and 80%) of millet sour dough and wheat flour

6.0 Master of Philosophy Students' Work

6.1 Students project progress

Formulation and Promotion of Pearl Millet Sourdough Extruded Snack Food for School Children in Ghana - (Mrs Edna Mireku-Essel)

6.1.1 Preparation of pearl millet sourdough

Processing is a prerequisite for manufacturing attractive whole grain products and increased consumption of whole grains. Processing must first of all render the food a suitable form and good palatability. Processing also is important in increasing extractability of nutrients and non-nutrients (Clydesdale, 1994). Processing may decrease or increase the levels of the bioactive compounds in grains and also modify bioavailability of these compounds as reviewed by Slavin et al., (2000). Sourdough process can be used to modify the levels of bioactive compounds.

6.2 Method

The millet sourdough was obtained by soaking the raw millet grain in water after sorting and cleaning. The soaking was observed at three different time streams, 24h, 36h and 48h. The samples obtained after soaking were each divided into two halves. One portion each of the sample was dried in an air oven (Apex dryer, Apex construction Ltd, London W.I. Type B35E) at 60^0C until dried. The dried millet was then milled to obtain a flour sample to be used for further analytical work. However, the other portion of each sample was milled after soaking and then prepared into a dough. The dough was fermented for 24h and 48h. The sample after fermentation was spread onto a drying tray and dried. The samples obtained were then milled into a flour for further analytical work.

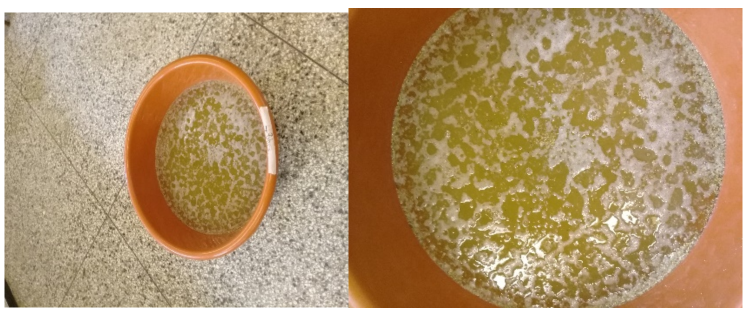


Figure 35: Soaked millet grains

Figure 36: Drying of millet after soaking

- Mycotoxicological Characteristics of millet grains and products along the millet value chain (Mrs Dorothy Narh)

- Development of starter culture for the fermentation of pearl millet into sourdough for the production of bread and extruded snack products in Ghana (Mr Micheal Amoo-Gyasi

6.3 ACTIVITY REPORT

6.3.1 MATERIALS &METHODS

One maxi bag (100 kg) of Pearl Millet grains was procured through the CSIR-Savanna Agricultural Research Institute, Manga station, Upper East Region, Ghana on 28th May, 2018.

All media and reagents for this research work has been procured.

6.3.2 Methods

The P. millet grains were analysed for the following Pathogens; Total Viable count, *Escherichia coli, Clostridium perfringens, Staphylococcus aureus, Bacillus cereus, Pseudomonas spp, Salmonella spp, Enterococcus spp, Yeast and moulds and Listeria monocytogenes*

Two (2) sets of experiments involving two (2) types of fermentations of P. millet into sourdough were conducted in August, 2018.

6.4 Analysis

4.4.1 Preparation of millet sour dough - Nigeria Method

P. millet grains were cleaned, washed, sun-dried, milled into flour and water added and kneaded into dough which was fermented for 72 hours.

Preparation of millet sour dough - Ghana Method

P. millet grains were cleaned and steeped in water for 24 and 48 h, milled and kneaded into dough and subsequently fermented for 24hrs, 48hrs, and 72hrs.

6.4.2 Microbial analysis

Lactic Acid Bacteria, Yeast and Total Viable Counts are analysed from 0hrs, 24hrs, 48hrs and 72hours.

6.4.3 Chemical analysis: Percentage Total titratable acidity (%TTA) and pH

6.4.4 Microbial analysis

Lactic Acid Bacteria, Yeast and Total Viable Counts were analysed.

Currently isolation of the fermenting organisms such as;

Lactic acid Bacteria Isolates are being screened for;

- Gram test
- Catalase test
- Oxidase test
- Cell morphology
- Colonial morphology

Yeast;

- Colonial morphology
- Cell morphology

.

.

7.0 Purchase of 200-250kg/h Extruder drying snack production line

The fabrication of the 200-250kg/h Extrusion line consists of a mixer, screw conveyor, KS-70 double screw extruder matched with 5 different dies of different shapes, screw conveyor, an electric dryer with 5 layers 5 meters, a flavouring system and a semi-automated packaging machine was ready. As a result CSIR-FRI millet sourdough project made the final payment to Jinan Keysong Machinery co

7.1 Pearl Millet Fermentation Experiments

Various experiments were carried out to determine the vitamin and mineral levels of fermented Pearl millet samples. The aim of these experiments was to ascertain whether the developed Pearl millet sour dough flour has the same minerals and vitamin contents as the fermented grain flour.

7.1.1 Methodology

Pearl millet samples (5kg) were weighed, sorted, washed thoroughly and soaked for 24h, 36h and 48h. The soaked samples were dried in an Apex dryer (U.S.A) at a temperature of 55°C for 4 hours. Dried samples were milled using laboratory mill and stored in air-tight polythene. A control sample was prepared by sorting the millet samples, washing, drying and milling. The minerals (Iron, phosphorus and calcium) and vitamin A and C will be determined for the four (4) samples.

Analysis on fermented millet flour conducted at CSIR-Food Research Institute

Table 4: Raw data for chemical analysis on millet flour

Parameter	Methods	Unit				
			Control millet flour	**24 hr millet flour**	**36 hr millet flour**	**48 hr millet flour**
Calcium	Based on AOAC 4.8.03 modified	mg/100g	26.62 29.92	39.86 26.64	36.48 46.45	46.57 46.62
Phosphorus	Based on AOAC 3.4.11 modified	mg/100g	293.60 357.40	298.98 364.65	260.0 269.55	281.09 270.55
Iron	Based on 2,2- bipyridyl colorimetric	mg/100g	4.38 4.62	5.59 5.72	4.85 4.61	4.87 4.99
Vitamin C	Based on 2,6- dichlorophenolindopheni	mg/100g	0.75 0.75	1.0 1.0	1.25 1.25	1.25 1.25

Table 5: Mineral and vitamin analysis of millet flour

Parameter	**Control**	**24Hr fermented Millet flour**	**36Hr fermented Millet flour**	**48Hr fermented Millet flour**
Calcium(mg/100g)	28.27±2.33	33.25 ± 9.35	41.47±7.05	46.59 ±0.04
Phosphorus(mg/100g)	325.50 ±45.11	331.82 ± 46.44	264.77 ± 6.75	275.82 ±7.45
Iron(mg/100g)	4.50 ± 0.17	5.65 ± 0.09	4.73 ± 0.17	4.93 ±0.08
Vitamin C(mg/100g)	0.75	1.0	1.25	1.25

Mean of duplicate determinations± standard deviation

Table 5 gives the results for the mineral and vitamin analysis of fermented and unfermented millet flour. The calcium value for the control was low compared to the other treatments. The highest value was recorded by the 48 h fermented millet flour (Table 5). Results for the phosphorus ranged from 264.77 to 331.82 (Table 5). Iron content was 5.65 mg/100g for 24h fermented millet flour and 4.73 mg/100g for 36h fermented flour. Vitamin c content was 1.25mg/100g for 36 and 48h fermented millet flour and 0.75mg/100g for the control. The results indicated that fermented of millet enhances the availability of minerals and vitamin contents.

8.0 Way forward

- The administered questionnaires will be collated and analyzed.
- Consumer acceptability on developed sour dough bread will be conducted.
- Trials will be conducted on the extrusion trials.
- Waiting for the arrival of the Twin screw Extruder for the extruded sour dough products
- Students will continue with their project works

THIRD QUARTER ACTIVITIES (July-September, 2018)

9.0 Consumer acceptability of millet sourdough bread

Objective

The objective of this study was to develop different formulations of millet sour dough bread using different proportions of millet sourdough and wheat flour and to assess consumer liking of the millet sourdough bread.

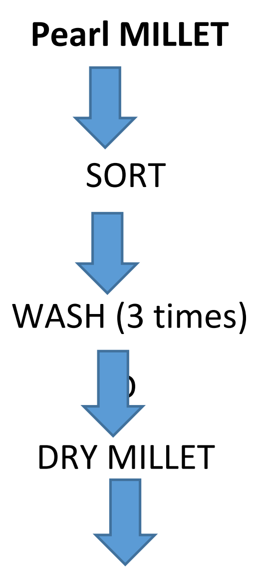
9.1 Materials and methods

9.1.1 Materials

Pearl millet samples were obtained from Manga in the Upper East region of Ghana.

9.2 Production of Pearl millet sourdough

Protocol for production of pearl millet sourdough



MILL

↓

MILLET FLOUR (CHECK MOISTURE)

↓

ADD WATER (1:1)

↓

FERMENT FOR 48 HOURS

↓

MILLET SOUR DOUGH

Table 6: Ingredients and weight used for Millet sour dough preparation

Ingredients	Weight (gms)
1. Millet Sourdough	240
2. Wheat flour	360
3. Water	180
4. sugar	20
5. Salt	10
6. Margarine	20
7. Nutmeg	0.1
8. Vanilla essence	2.5mls

9.3 METHODS FOR PREPARATION OF MILLET SOURDOUGH BREAD

Weight ingredients

↓

Sieve wheat flour

↓

Add sour dough to wheat flour (Depending on proportions)

↓

Mix thoroughly to form a dough

↓

Knead dough for 15mins until smooth

↓

Cut into desirable sizes and mold into well-greased baking pans

↓

Cover with clean cloth and allow it to proof (3-4h)

↓

Bake in a moderately hot oven set at 170°C for 35-45min.

↓

Remove, allow to cool and bag in polythene.

NB: The more sourdough used the lesser water used.

Figure 37: Millet sour dough

Figure 38: Kneading of Millet sour dough and wheat flour

Figure 39: Prepared Millet sour dough bread (40% and 80%)

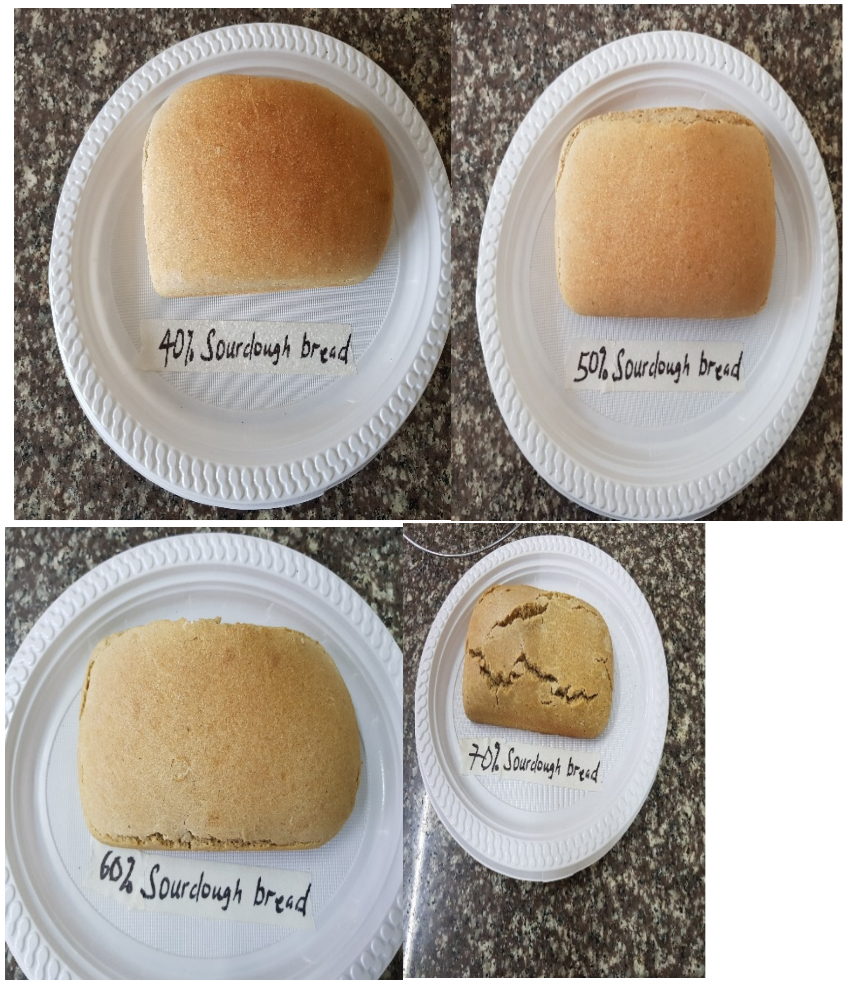


Figure 40: Baked Millet sour dough bread (40%, 50%, 60% and 70%)

Figure 41: A consumer assessing the Millet sour dough bread samples

9.4 Methods

Different formulations of Pearl millet sourdough bread were prepared per the method shown in the flow diagram above. The formulations used were as follows: 90% millet sourdough, 80% millet sourdough**,** 70% millet sourdough, 60% millet sourdough**,** 50% millet sourdough and 100% millet flour.

9.5 Consumer acceptability of Pearl Millet sour dough bread

Pearl millet sourdough bread were prepared using 7 different formulations *of* the millet sour dough (90%, 80%, 70%, 60%, 50% and 100% millet flour for consumer analysis. Bread prepared using 100% millet flour was the control sample. Consumers (50) were used in the study. The consumers were selected according to criteria of familiarity with the product. The consumer tests were carried out in the Sensory Science Laboratory of the CSIR-Food Research Institute. The samples were evaluated on a nine-point hedonic scale (1- dislike extremely, 5- neither like nor dislike and 9- like extremely) as suggested by Tomlins *et al*., (2005), Meilgaard *et al*., (1988), based on the attributes of appearance, colour(crust), colour(crumb), Aroma, taste, sponginess, aftertaste and overall acceptability.

All the seven (7) millet bread samples were presented randomly on white plates labelled with three random digits codes. The samples were served to consumers in two (2) days, four samples and three samples respectively. Consumers were offered mineral water and cucumber to rinse their mouths between samples. The panelists' were asked to freely write down comments about the product on the score sheet.

9.6 Colour Determination

The colour of the millet sourdough bread samples were measured using a Minolta Chromameter CR310-Japan colorimeter model D25-PC2 (Hunter of employees of the National Institute of Aglaboratories, Reston, VA) after calibration using a white tile (L=97.51, a=5.45, b=-3.50) according to AACC Method 14-22.01, 2000). where lightness (L)= (+), green (a)=(-); yellow (b)= (+), blue (b)=(-) colour value. Analysis was conducted five times per sample and the mean calculated.

9.7 Evaluation of the baking qualities of bread samples

9.7.1 Loaf weight

The loaf weight was determined by weighing the bread loaves 20 mins. After baking, using the laboratory scale (CE- 410I, Camry Emperors, China) and the readings recorded in grammes.

9.7.2 Loaf volume

The loaf volume was determined by using Rape seed displacement method (AACC, 2000, Standard 10-05). This was done by loading sorghum grains into an empty box with calibrated mark until it reached the marked level and unloaded back.

The bread sample was put into the box and the measured sorghum was loaded back again.

The remaining sorghum grains left outside the box was measured using measuring cylinder and recorded as loaf volume in cm^3.

9.7.3 Specific volume

The specific volume (volume to mass ratio) (cm^3/g) was thereafter calculated.

9.7.4 Determination of loaf volume of composite bread

The loaf volume of each bread sample was measured 50 minutes after the loaves were removed from the oven by using the rape-seed displacement method as described by Onwuka (2005).

Volume of Sourdough Bread

Seed displacement

Procedure

1. A loaf of bread was weighed after it was cooled to room temperature, the weight was recorded as (W)

2. A rigid container (A) was filled with millet seeds and the surface of the millet seeds was leveled with a ruler.

3. The millet seeds was poured into another container (B) and a thin layer of the millet seeds was left at the bottom of the container A

4. The bread was placed on the layer of the millet seeds in container A.

5. The container A was filled with the millet seeds and the surface was leveled with a ruler.

6. The remaining seeds was poured in container B into a measuring cylinder and the volume V was obtained.

10.0 Results and discussion

Table 7: Mean scores of appearance, colour (crust and crumb), aroma, sponginess, taste, and overall acceptance for 7 millet sour dough bread samples

Millet sourdough samples	Appearance	Colour (crust)	Colour (crumb)	Aroma	Taste	After taste	Sponginess	Overall accept
Control	7.8 ± 1.02^{a}	7.7 ± 0.80^{a}	7.1 ± 1.32^{a}	7.6 ± 1.17^{a}	7.7 ± 1.05^{a}	7.7 ± 1.06^{a}	7.2 ± 1.18^{a}	7.9 ± 1.06^{a}
40%	7.2 ± 1.21^{abc}	7.0 ± 1.25^{abc}	6.8 ± 1.26^{a}	6.8 ± 1.24^{bc}	6.2 ± 1.58^{b}	5.7 ± 1.61^{b}	6.5 ± 1.39^{ab}	6.4 ± 1.51^{bc}
50%	7.3 ± 0.87^{ab}	7.2 ± 1.00^{ab}	6.8 ± 1.10^{a}	6.8 ± 1.00^{ab}	6.3 ± 1.34^{b}	5.8 ± 1.47^{b}	6.5 ± 1.41^{ab}	6.7 ± 1.48^{b}
60%	6.4 ± 1.47^{c}	6.3 ± 1.49^{cd}	6.7 ± 1.22^{a}	6.0 ± 1.70^{c}	4.9 ± 1.78^{cd}	4.7 ± 1.87^{c}	6.2 ± 1.54^{b}	5.5 ± 1.59^{c}
70%	6.6 ± 1.14^{bc}	6.4 ± 1.35^{bc}	6.5 ± 1.21^{a}	6.3 ± 1.46^{bc}	5.5 ± 1.52^{bc}	5.0 ± 1.48^{bc}	5.8 ± 1.39^{b}	5.7 ± 1.58^{c}
80%	5.0 ± 1.90^{d}	5.0 ± 1.95^{e}	5.1 ± 1.93^{b}	4.9 ± 1.97^{d}	3.5 ± 1.95^{e}	3.5 ± 1.98^{d}	4.0 ± 1.79^{c}	3.6 ± 1.93^{d}
90%	5.5 ± 2.08^{d}	5.5 ± 2.11^{de}	5.0 ± 1.98^{b}	5.0 ± 1.66^{d}	3.9 ± 1.84^{de}	3.5 ± 1.49^{d}	4.4 ± 1.92^{c}	4.3 ± 2.01^{d}

Values within columns with different letters are significantly different at $p < 0.05$

The results of the sensory evaluation of the sourdough bread are presented in Table 7. Generally, the sourdough bread samples were significantly different for all the parameters evaluated. As expected the control sample (30% millet flour and 70% wheat flour) performed better in all the parameters evaluated, having a score range of 7.1 to 7.9 followed by sample 50% recording a score range of 5.8 to 7.3. Sample 80% millet sour dough bread was the least preferred among all samples evaluated.

The appearance of the sourdough bread samples revealed that all the samples were significantly different except for 80% and 90% sourdough bread samples. This implied that the appearance of 80% and 90% sourdough bread samples were similar but different from the other samples. The appearance of samples 80% and 90% sourdough bread was the least preferred by the consumers. The appearance of the control sample was liked most (7.8, liked very much) followed by sample 50% (7.3, liked moderately).

The colour (crust) of the samples underwent a similar trend with the control sample being preferred the most (7.7) followed by 50% (7.2), whilst 80% was the least preferred (5.0). Concerning the colour of the crumb, the control sample scored the highest (7.1) followed by 50% (6.8) and 40% (6.8). Sample 90% scored the least (5.0). Consumers neither liked nor disliked the sample. The aroma of the control sample was most preferred (7.6, liked very much), followed by 50% (6.8) and 40% (6.8). After taste and sponginess followed a similar trend. Regarding taste, control sample was the most preferred followed by sample 50%. Sample 80% millet sourdough bread taste was the least preferred (3.5, disliked slightly).

The control sample had the highest overall acceptability score of 7.9 (liked very much), followed by 50% sample recording a score of 6.7 (liked moderately). Sample 80% recorded the least overall acceptability score of 3.6 (disliked slightly).

Table 8: Colour measurement of sourdough Bread

Millet sour dough bread samples		**L**	**a**	**b**
40%	Crust (outside)	56.84 ± 1.77	10.32 ±0.03	19.96 ±0.98
	Crumb (inside)	63.96 ± 0.50	1.65 ± 0.05	12.81± 9.97
50%	Crust(outside)	57.59 ± 1.51	8.31± 0.33	27.91 ± 0.64
	Crumb (inside)	62.33 ± 0.38	1.94 ± 0.09	18.67 ± 0.22
Control	Crust (outside)	53.41 ± 0.53	11.68 ± 0.22	27.38 ± 0.31
	Crumb (inside)	64.25± 1.29	1.47 ± 0.04	19.50 ± 0.25
60%	Crust (outside)	53.97 ± 0.60	9.65 ± 2.60	28.12 ± 0.20
	Crumb (inside)	63.72 ± 1.47	1.89 ± 0.12	18.52 ± 0.40
80%	Crust (outside)	55.52 ±1.27	3.73 ± 0.07	21.96 ± 0.12
	Crumb (inside)	56.61± 0.81	2.17± 0.04	17.27 ± 0.05
70%	Crust (outside)	56.01±2.66	4.81 ± 0.29	24.46 ± 0.43
	Crumb (inside)	59.37± 0.73	1.88 ± 0.02	17.32 ± 0.12
90%	Crust (outside)	53.77 ± 0.45	2.85 ± 0.06	17.48 ±0.13
	Crumb (inside)	57.43 ±0.31	1.95 ±0.04	16.29 ±0.14

The colour measurement for the crust and crumb of the different formulation of millet sourdough bread is shown in table 8. The L values for the crust (outside) ranged from 53.41 to 56.84 (Table 8) for control sample and 40% millet sourdough bread respectively.

The colour of the crumb (inside) varied from 56.61 for 80% millet sourdough bread and 64.25 for the control sample.

Table 9: Baking qualities of millet sour dough bread samples

Sample	Weight (*g*)	Volume (cm^3)	Specific volume (cm^3/g)
Control	456.3	1190	2.61
40%	332.2	810	2.44
50%	323.8	644	1.99
60%	316.5	394	1.24
70%	303.5	390	1.29
80%	286.9	200	0.70
90%	271.6	110	0.41

The baking qualities of millet sourdough bread samples are shown in table 9. The weights of the bread were from 271.6 to 456.3g. The control samples recorded the highest weight and the 90% millet sourdough bread recorded the least weight. The weight results decreased as the percentage of the millet sour dough increased and this can be attributed to the fact that the wheat flour is lower in this case and the gluten does not raise enough compared to when low percentage millet sourdough is used where the amount of wheat flour was high and the bread raises thus increasing the weight of the bread. The volume of the bread varied from $1190cm^{3}$ to $110cm^{3}$.

The decrease in loaf volume with subsequent addition of millet sourdough might be due to less retention of carbon dioxide (CO_2) as explained by Rao and Hemamalini 1991. It is also obvious that substitution of wheat flour by other flour reduces the gluten fraction which is the source of elasticity in dough. This elasticity helps in retaining carbon dioxide produced during fermentation. Reduced gluten fraction in 60%-90% millet sourdough bread caused a compact, compressed less aerated texture and decreased raise in loaf size. These results are in agreement with Gomez *et al*., 2003 and Yusinta and Wong, 2011, according to them, addition of dietary fiber rich substances in baking products reduce loaf volume. Similar trend of results were obtained for specific volume of millet sourdough bread in present study and are shown in Table 9.

11.0 Conclusion

Millet sourdough bread prepared using 50% and 40% formulation was the second preferred apart from the control sample. The millet sour dough prepared using 80% of the sourdough was highly disliked

Refurbished Location for siting of Twin screw Extruder

Figure 42: Refurbished room for siting twin screw Extruder

12.0 Progress of Master of philosophy students' thesis work

Project activity report mycotoxicological study in millet sourdough value chain

DOROTHY NARH (MPHIL STUDENT)

SUPERVISORS

PROFESSOR WISDOM PLAHAR
PROFESSOR MARY OBODAI

MR. GEORGE ANYEBUNO

Main Objective

To ascertain the Mycotoxins levels and their relation to Moisture and water Activity on the millet sourdough value chain.

Specific objectives

- To obtain random samples of raw pearl millet from the farm, market, processor and consumer levels on the millet sourdough value chain.
- To determine the levels of Mycotoxins (Aflatoxins B1, B2, G1& G2, Patulin and Ochratoxin A) of the pearl millet samples along the millet sourdough value chain by Higher Performance Liquid Chromatography (HPLC)
- To determine the moisture content (Mc) using AOAC methods 925.09 (AOAC 1998).
- To determine Water Activity (Aw) using the water activity meter.

Process Flow for Production of Pearl Millet Sourdough

RAW PEARL MILLET

SORTING

WASHING

DRYING

MILLING

MILLET FLOUR PREPARATION OF

DOUGH **FERMENTATION OF**

DOUGH MILLET SOURDOUGH

SOURDOUGH PRODUCTS

The analysis will be carried out on the following on the millet sourdough value chain.

- Raw Pearl millet
- Pearl Millet flour for processing baked products and extruded snacks
- Pearl Millet dough during fermentation
- Millet Sour dough at different millet flour to water ratio
- Millet Sour dough products

Materials and Methods

Raw pearl millet from randomly selected farms and markets in the Upper East, Upper West and Tamale in the Northern Region are being obtained. Currently the millet farms in the Northern part of Ghana have started harvesting the early millet grains. A follow up in the Northern Region shows that farmers will start harvesting the late millet from October, 2018.

Procurement of farm and market samples from Sandema and Navrongo is ongoing in the Upper-East Region for commencement of work on the market and farm level whilst awaiting the late millet harvest samples.

Methods

Chemicals have been purchased for the commencement of the Mycotoxins analysis on the sourdough flour and sourdough bread products in October, 2018. Mycotoxins analysis would be carried out using in the Food Research Institute Chemistry Laboratory in Ghana. .

Water Activity (Aw) analysis on the sourdough flour and sourdough bread product is ongoing in the Unit of Biochemistry and Molecular Biology Laboratory in Benin.

Moisture Content Determination (Mc) on the sourdough flour and sourdough bread products is ongoing in the Food Research Institute Chemistry Laboratory in Ghana.

Figure 43. Samples of Raw Pearl Millet Grains

Figure 44:Samples of Pearl Millet Flour for Extruded Products

Figure 45. Samples of Pearl Millet Flour for Sourdough Bread

Figure 46. Samples of Pearl Millet Sourdough Bread

PROGRESS REPORT ON THE PRODUCTION AND FORMULATION OF PEARL MILLET SOURDOUGH EXTRUDED SNACK.

EDNA MIREKU ESSEL

Introduction

1.1 Background

Cereal foods of different forms are an important part of our daily diet. They are an important source of carbohydrates, protein, dietary fiber (DF) and many vitamins and non-nutrients (food components not essential for growth but with potential biological functions such as fructans).

Millets are minor cereals and form the staple food for a large segment of the population in India and Africa. However utilization of millet for food is still mostly confined to the traditional consumers and population in lower economic strata, partly because of non-availability of these grains in ready to eat forms.

Processing is a prerequisite for manufacturing attractive whole grain products and increased consumption of whole grains. Processing must first of all render the food a suitable form and good palatability. Processing also is important in increasing extractability of nutrients and non-nutrients (Clydesdale, 1994). Processing may decrease or increase the levels of the bioactive compounds in grains and also modify bioavailability of these compounds as reviewed by Slavin, Jacobs and Marquardt (2000). Sourdough process can be used to modify the levels of bioactive compounds.

1.2 Statements of the Problem

Millets are nutritionally comparable and even superior to major cereals in terms of energy value, protein, fat and minerals (Anu et al. 2006; Malik et al. 2002). However, due to the presence of anti-nutrients like phytate, polyphenols, oxalates and tannins, mineral availability is affected. These anti-nutrients form complexes with dietary minerals such as calcium, zinc and iron leading to a marked reduction in its bioavailability and make them biologically unavailable to human organism (Arora et al. 2003).

Sourdough fermentation can modify healthiness of cereals in a number of ways. It can improve texture and palatability of whole grain, fiber-rich or gluten- free products, stabilize or increase levels of various bioactive compounds, retard starch bioavailability and improve mineral bioavailability. However, many new interesting applications for sourdough remain still to be explored, such as the use of a sourdough flour to develop extruded snacks.

Hence this project seeks to use sourdough millet o develop extruded snacks.

Literature Review

2.1 Millet Production and importance

Millets represent a collective term referring to a number of small-seeded crops belonging to grass family, Graminae. They are cultivated as grain crops primarily on marginal lands in dry temperate areas such as subtropical and tropical regions. Millet serves as a staple food in parts of India, Africa, China and other parts of the world. However they are mostly produced in Asia and Africa.

Millet, an important cereal crop plays a major role in the food security and economy of many less developed countries in the world. Millet cultivation dates back to about 5,500 BC in China (Crawford, 2006). It is thought to be the first grain cultivated by man. Millets ranks as the sixth most important cereal and feeds one third of the total world population (Saleh et al. 2013). They are easy to cultivate, inherently bio-diverse and can be grown together with varied crops (Rachie 1975; Dendy 1995). Millet are a preferred choice in areas where they are cultivated because they have a short harvest period (45-65 days) (Bukhari et al. 2011).

Millet consumption is gaining importance in North America and European countries due to its gluten-free and hypoglycemic properties. In these countries, millets are mainly used as an ingredient in composite mixes to produce gluten-free and low glycemic index (GI) food products. Thus the production of a 100% millet flour products are rare in these countries. However in African and Asian countries, millets serve as the main ingredient for preparation of traditional foods and beverages (Saleh et al. 2013).

Pearl millet is a widely grown rain fed cereal crop in the arid and semiarid regions of Africa and southern Asia. Pearl millet (Pennisetum glaucum) is the most important crop in the drier parts of semi-arid tropics and accounts for almost half of the global production of the millet species from amongst different species of millets cultivated. India is the largest producer of pearl millet in Asia and is mainly grown in northwestern parts (Dendy 1995; Obilana 2003). It is also the major millet grown in Nepal and Bhutan (Mal *et al*. 2010).

<u>Preparation of pearl millet sourdough</u>

Method

The millet sourdough was obtained by soaking the raw millet grain in water after sorting and cleaning. The soaking was observed at three different time streams, for 24h, 36h and 48h. The samples obtained after soaking were each divided into two halves. One portion each of the sample was dried in an air oven (Apex dryer, Apex construction Ltd, London W.I. Type B35E) at 60^0C until dried. The dried millet was then milled to obtain a flour sample to be used for further analytical work. However, the other portion of each sample was milled after soaking and then prepared into a dough. The dough was fermented for 24h and 48h. The sample after fermentation was spread onto a drying tray and dried. The samples obtained were then milled into a flour for further analytical work.

Figure 47: Kneading the millet into a dough for further fermentation after soaking.

Physicochemical and nutritional analysis on millet flour and the fermented dough

The millet flours and fermented dough obtained (will be examined for the following parameters. Proximate analysis - Moisture, ash and fat contents were determined, in triplicate, using AOAC methods 925.09, 923.03 (AOAC 1998) and AACC method 30-25 (AACC 1995), respectively. Protein analyses will be determined using an FP2000 Protein/Nitrogen Analyzer (LECO Corp., St. Joseph’s, MI) and a conversion factor of N ¥ 6.25. Water absorption (WAI) and water solubility (WSI) indices were determined by modifying the methods reported by Jin et al. (1995). Swelling power and solubility will be determined by method describe by Afoakwa et al (2012). Other analysis will include lactic acid, pH, phosphorus, iron, calcium, phytic acid, vitamin A, vitamin C and flavor profile on the fermented dough.

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APPENDIX

Appendix 1: Fermented millet flour Experiment

Pearl Millet grains

Washing of Pearl Millet grains

Soaking of Pearl millet grains for 24h, 36h& 48h

Soaked Pearl millet grains

Washing of soaked grains.

Drying of soaked grains in a mechanical dryer at 55°C

Milling of soaked and Pearl millet dried grains

Fermented milled Pearl millet flour

24h and 36h fermented Pearl Millet flour

Unfermented Pearl millet flour and 48h fermented Pearl Millet flour

Appendix 2: Program for Inception meetings at FUNAAB

Tuesday 06 March 2018

Opening Ceremony

10:00 – 11:00 Arrival and Registration of participants and Guests

11:00 – 11:15 Introduction of Guests

11:15 – 11:30 Welcome Address by Project Co-Leader (Nigeria)

11:30 – 11:45 Goodwill message from EMBRAPA

11:45 – 12:00 Opening Remarks by Vice Chancellor and formal Opening

12:00 – 12:30 Group Photograph and Departure of Invited Guests/Tea break

Project Meeting

12:30 – 01:00 Introduction (Who is who)

01:00 – 02:00 Project Overview

02:00 – 03:00 Lunch

03:00 – 05:00 Country Presentation

05:00 – 06:00 Departure to Hotel

Wednesday 07 March 2018

09:30 – 10:30 Students Presentation

10:30 – 11:00 Tea Break

11:00 – 01:00 Student Presentation

01:00 – 02:00 Lunch

02:00 – 05:00 Update from Nigeria Team

05:00 – 06:00 Departure to Hotel

Thursday 08 March 2018

09:30 – 10:30 Country Workplan

10:30 – 11:00 Tea Break

11:00 – 01:00 Country Workplan

01:00 – 02:00 Lunch

02:00 – 05:00 General Discussion

- Issues/Challenges
- Update on Equipment
- Analysis
- Copies of Students Thesis
- Publications

05:00 – 06:00 Departure to Hotel

Friday 09 March 2018

09:00 – 12:00 Visit to Olumo Rock

12:00 – 02:00 Visit to Adire Market

02:00 – 04:00 Departure to Airport

BALLOT SHEET FOR ACCEPTANCE OF MILLET SOURDOUGH BREAD

Name: ---

Instructions:
You have been provided with seven samples of millet bread, which you are to evaluate by indicating your degree of liking for each sample attribute of the sample.
Please clean your palates or rinse your mouth with water or cucumber in between samples.

Scale/Interpretation
9. Like Extremely
8. Like Very much
7. Like Moderately
6. Like Slightly
5. Nether Like nor Dislike
4. Dislike Slightly
3. Dislike Moderately
2. Dislike Very much
1.Dislike Extremely

Attributes	☐	☐	☐	☐
Appearance	----------	----------	--------	---------
Colour (Crust)	----------	---------	--------	---------
Colour (Crumb)	--------	---------	-------	---------

Aroma	---------	---------	--------	---------
Taste	--------	---------	-------	---------
After taste	----------	----------	---------	---------
Sponginess	----------	---------	---------	--------
Overall acceptability	------	---------	---------	---------

Crust is the brown, hard outer portion or surface of a loaf or slice of bread

Crumb is the pattern of holes inside of a loaf.

Any additional comments?

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