THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE
Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

CONTRIBUTION TO THE IMPROVEMENT OF THE COMPLEMENTARY FOODS BY THE TECHNIQUE OF GERMINATION AND FERMENTATION

Abstract:
The infant flours were prepared from mixed flours of maize (*Zea mays*), white sorghum (*Guinea sorghum*) and soybean (*Glycine max*) and saccharose in proportion 29.40/29.40/29.40/11.80 respectively in flour germinated (Formula F_3). The proportion was 28.30/28.30/28.30/3.8/11.30 respectively in the fermented flour (Formula F_A). The formula F_3 contained 69.20 ± 0.8 total carbohydrates, 7.5 ± 0.5 fat with essential fatty acid (linoleic acid (16.5 ± 0.5) and α-linolenic acid (3.8 ± 0.3)) and 15.80 ± 1.4 protein. Characterized by some essentials amino-acids such as histidine, threonine, lysine, isoleucine, leucine, phenylalanine, tyrosine, cysteine, methionine, tryptophan and valine. As to the formula F_A contained 68.50 ± 0.5 total carbohydrates, 4.5 ± 0.5 fat with essential fatty acid (linoleic acid (15 ± 1) and α-linolenic acid (3.5 ± 0.1)) and 15.17 ± 0.83 protein with all essentials amino-acids.The microbiological analyses of the fermented flour and the germinated flour, they don't contain pathogenic germs susceptible to have repercussions on the health of the infant. The weaning mush (Formula F_3) had a fluid consistency with flow distance (120 mm/30 seconds) compared 90 mm/30 seconds formula F_A. The sensory evaluation showed that the porridge prepared from the germinated flour F_3 and from the fermented flour F_A were accepted by the children.
Keywords: Germination, fermentation, complementary food, porridge.

Introduction:

Protein energy malnutrition among children is the major health challenges is developing countries (FAO, 2001). This nutrition problem is ascribed to the inappropriate complementary foods (Eka *et al* 2010). The local raw materials frequently used for the preparation of complementary infant feeding such as porridge are cereals and tubers which are accessible to the most disadvantaged population. However, the nutritional quality of porridge from cereals is insufficient (Blandino *et al*; 2003). Indeed, these foods under normal cooking and consumption conditions cannot effectively complement breast milk energy intake deficits, because of their low energy density.
Industrial manufacture of cereal based weaning foods often includes operations intended to reduce the dietary bulk, enzyme (amylase) treatment, extrusion (Mourci *et al*, 2003). The processes modify the starch structures and hence result in lower water binding in the porridge. However, such sophisticated technologies make rather expensive products even when low cost alternatives are normally only available to urban children of higher income families (Muhimbaly *et al*, 2011). The alternative to industrial processes for reducing the dietary bulk of cereal based weaning foods seems to be increased use of improved traditional food preparation procedures that will also modify, starch structures. The procedure that is widely knows and used are fermentation and germination. The germination of cereals is mainly associated with the preparation of local alcoholic beverages, but there are also a few examples where this procedure is used in preparing local weaning foods with seemingly low dietary bulk.
The objectives of this study therefore to assess the nutrition quality and hygienic flours based of maize, sorghum and soybean according to the technique of germination and fermentation. Besides, a sensory profile of porridges developed from these flours will also be estimated.

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY
ISSN-2319-2119
RESEARCH ARTICLE
Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

Materiel and methods

Collect of food materials: The materials used in this study were locally available maize, sorghum, soybean and sugar which were collected from local market.

Production of germinated flour

The maize, sorghum, soybean were prepared by taking the cereals seeds. The cereals seeds were taken in a bowl and washed with tap water to clean the grains properly .The seeds were then soaked in double quantity of water for about 9 hours to accelerate germination: After soaking the seeds were allowed to germinate at 30 + 2°C for 72 h by placing on a cotton cloth and also covering with cloth. Water was sprayed after 2 hours to keep the seeds wet. After germination the sprouts were washed and dried at 65°C for 48 hours in an electric over.

Production of fermented flour

The different proportions of maize, sorghum and soybean flours were mixed in water (100 ml) with a small amount of cassava fermented before. The paste thus obtained is to ferment for three days. At the end of fermentation, the paste was dried at 65°C for 48 hours in an electric over.

Preparation and characterization of porridge:

The porridge was prepared in aluminum sauce pan different proportions of maize, sorghum and soybean malted flours were mixed in water (180 ml) in accordance with Mouquet method (1998). The flow distance (mm) 30 sec of the gruels obtained was measured using a Bostwich consistomater a according to the method used by Vieu *et al* (2001).

Preparation of compound flours

The weaning flours were mixed as follows: flour germinated the Formula F_3 contains (29.40 % malted maize, 29.40 % malted sorghum, 29.40 % malted soybean and 11.80 % sugar) and the flour fermented the Formula F_A contains (28.30 % maize, 28.30 % sorghum, 28.30 % soybean, 3.80 % ferment and 11.30 % sugar).

Physicochemical characterization of flours

Evaluation of some biochemical characteristics of flours

The dry matter, moisture, cellulose and ash contents were determined by the standard method (AOAC, 1995). Total sugars extracted with chilled 80 % ethanol were assayed by the method of Dubois *et al*. (1956) .The determination of total carbohydrates was performed according to the methodology described by Bertrand and Thomas (1910).
The content of starch was determined by difference between the rate of total carbohydrates and that of total sugars. The proteins content was assayed by the Kjeldahl method, (AOAC, 1995).
The fat was extracted according to AOAC method (1995) using the soxhlet.
Amino acids were determinated according to method of Bidlingmeyer, Cohen and Strydom (1988). Fatty acids were determined by method of Morrison (1978) and Uceda, Hermoso (1996).
The flour energy value (EV) was calculated using the method of Atwater and Benedict (1902) with the following equation:

EV: (9 x % Lipid) + (4 x % Protein) + (4 x % Glucid)

Enumeration and identification of microorganism

Preparation of stock solutions inoculation of agar plates and cultivation and quantification of microorganisms were carried out according to Coulin *et al* (2006). For all determination, 10 g of the samples was homogenized in a stomacher bag with 90 ml of sterile peptone buffered watered (AES Laboratory, Combourg, France) .Ten fold serial dilutions of stomacher fluid were prepared and spread- plated for counting microorganisms.
Enumeration of coliforms was carried out using VRBL (Violet Crystal and Neutral Red Bile Lactose) plates containing agar (VRBL, agar, oxoid Ltd, Basingstore ,UK) which were incubated for 24 h at 37 °C for total coliforms and 44 °C for fecal coliforms.

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY
ISSN-2319-2119
RESEARCH ARTICLE
Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

Yeasts and molds were enumerated on plates of Sabauraud Chloramphenicol Agar (Fluka, Biochemica 89579, Sigma-Aldrich Chimie GmbH, India) incubated at 30 °C for 5 days. Aerobic Mesophiles enumerated on plates of Count Agar (PCA Oxoid Ltd) and incubated at 30°C for 72 h.

Sulfito reducers were enumerated on plates of TSN (Tryptone Sel Neomycin) and incubated at 46 °C for 48 h.

To enumerate Salmonella spp, flour samples were suspended for 2 min in 225 ml lactose broth (Merck HG00C97) and homogenized in a sterile stomacher bag and then pre-enriched for 24 h at 35-37 ºC. Thereafter, 1 ml of the pre-enriched culture was transferred to Selenite Cysteine (SC) (Merck 1.07709) broth and incubated for 18-24 h at 35-37 ºC (Wallace *et al.,* 2001). Concurrently, 0.1 ml of the pre-enriched culture was transferred into 10 ml of Heketonic Enteric (HE) agar (Acumedia 7138) plates and incubated for 24 h at 35 ºC.

Sensory Evaluation

Sensory attributes like color, flavor, taste and overall acceptability were evaluated by judges using 5 point hedonic score system. The panelist gives score from five (5) to one (1) to the product ranging from "like" to "dislike" to find out the most suitable composition of flours.

Statistical Analysis

All determinations reported in this study were carried out in triplicates. Mean values and standard deviations were calculed. Analysis of variance (Anover) and correlations were also performed. Turkey's (HSD) Test at P ≤ 0,05 was used for mean values separation.

Results and Discussions:

Chemical composition of simple flours

Table 1 show the biochemical composition of sorghum, maize and soybean and germinated maize, sorghum, soybean.

The maize flour has a high value in carbohydrates (75 %), starch (62.5%) and low content in protein, ash, fat and cellulose (9.6 %, 1.5 %, 4.8 % and 2.8 % respectively). The sorghum flour has a high content of carbohydrate (74.30 %), starch (60.5 ± 0.5^a) but a low content of protein, ash, fat and cellulose with respective values of 10.9 %, 2 %, 4.3 % and 2.6 %. The soybean flour has a high content of protein (40 %) and fat (18.3 %) but a low content of carbohydrate, starch, ash and cellulose (35.5 %, 32 %, 3.5 % and 3.4 % respectively).

However, the germinated maize flour has a high value in protein, ash, fat, respectively (10.5 %, 2.5 %, 7.9 %) but a low content of carbohydrate, starch and cellulose with respective values of 66.5 %, 26 %, 2.5 %. Moreover the germinated sorghum flour has a high content in protein (11 %), ash (2.8 %) and fat (6.6 %) and low content of carbohydrate, starch and cellulose (67.25 %, 28.7 % and 2.3 % respectively). Finally the germinated soybean flour has a high content of protein (42,8 %) , fat (19.5 %) and ash (4.5 %) but a low content of carbohydrate, starch and cellulose with respective values of 30.5 % , 20.3 % , 2.7 % .

The increase in protein, ash and fat content could be due to biosynthesis during germination (Ghavidel, 2006). However, the carbohydrate, starch and cellulose content were decreased for the maize, the sorghum and the soybean after germination. This study are corroborated with other's (Ghavidel, 2006), Wang *et al*, 2008.

The mineral composition of the flours presented in table 1 showed that the potassium, phosphorus, iron, calcium were the highest in the maize, sorghum, soybean and soybean germinated while the magnesium, zinc and sodium were the least in the germinated maize, sorghum and soybean. Ash content represents the total mineral content in food. Mineral contents significantly increased in composite flours. This was expected and is in agreement with literature report (Iwe and Onuh, 1992). The relative high mineral contents indicate that composite flours are good sources of minerals brought by the supplementation with soybean. According to certain investigators, cereals were deficient in many vital nutrients and therefore could not supply alone the necessary nutrient requirement for the rapid growth and dévelopement of children. So it appears necessary to complement them with soybean in order to

INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

improve their nutritional values (Malleshi *et al.,* 1999).

Characteristic Rheological of flours

The porridge from the germinated flour has a dry matter of 30.60 %, an energy density of 122.4 Kcal / 100g MS and a fluidity of 120 mm /30sec .The porridge from the fermented flour has a dry matter of 22.67 %, an energy density of 90.68 Kcal /100 ml and 90 mm / 30sec fluidity (Table 2). The energy value of the germinated flour has a high than the fermented flour; this observation result of the biochemical activities to the germination and the activities of microorganisms from the fermentation. Khatoom et Prakash, 2006; Kaushik *et al* 2010 indicated that the method of germination and the fermentation improves the nutritional quality of complementary foods and also the energy value of the produced food (Syed *et al* 2011).

Nutritional value of composite flour germinated and fermented F_3 and F_A

Chemical composition of the flours F_3 and F_A

The composite flour germinated F_3 contains 69.20 % of carbohydrates, 15.80 % of proteins and 7.5 % of fat and the energy value is 402.37 Kcal/100 g. The fermented flour F_A contains 68.50 % of carbohydrates, 15.17 % of proteins, 4.5 % of fat and the energy value is 375.12 Kcals /100g. The germinated flour has a high content in fat (7.5 %), cellulose (4 %) ash (2.8 %) than the fermented flour 4.5 %, 3.5 % and 2.6 % respectively. There is no significant difference in the threshold $P \leq 0.05$ between the germinated flour and the fermented flour as regards carbohydrates, proteins and starch (Table 3). The germinated flour and the fermented flour respected the criteria of WHO (1998). The consumption of these flours could protect the children from infantile malnutrition according to Mouquet *et al* (2006).

Composition in amino acids of composite flour germinated and fermented F_3 and F_A

There is a significant difference between the germinated flour F_3 and the fermented flour F_A as regards the thréonine, the lysine, the isoleucine, the leucine, the cysteine + méthionine, the tryptophan and the valine, however there is no significant difference between the germinated flour and the fermented flour for the histidine and the phénylalanine + tyrosine at the threshold of $P \leq 0.05$ (Table 4). Essential amino acids of the germinated flour was decreasing with regard to the fermented flour, it could be attributed to the activities of the microorganisms which secrete nutriments during the period of fermentation. Amino acids were used for the growth by seeds in seeding. These essential amino acids would be useful of synthesis protein. (Sanni *et al* . 1999).

Composition in fatty acids of composite flour germinated and fermented F_3 and F_A

The germinated flour F_3 contains saturated fatty acids 59.1 % that is: the acid caprylic 3.3 % ; acid lauric 1.1 % ; acid myristic 10.5 % ; acid palmitic 30 %; stearic acid 14. 2 %. The content in fatty acid monounsaturated is 20.6 % among which 18.2 % of acid palmitoléic and 2.4 % of acid oléic. The content in polyunsaturated fatty acids is 16.50 % the linoleic acid and 3.8 % α-linolénic.
The fermented flour F_A contains saturated fatty acids 63.6 % that is 2.8 % of acid caprylic,1.5 % of acid lauric; 12 % of acid myristic; 35 % of acid palmitic and 12.3 % of acid stearic. The content in mono fatty acid unsaturated is 17.9 % among which 2.4 % of acid palmitoleic and 16.5 % of acid oleic. The content in fatty acid polyunsaturated is 15 % the linoleic acid and acid 3.5 % α-linolénic (Table 5).

There is no significant difference between the germinated flour F_3 and the fermented flour F_A as regards the contents in acid caprylic, in acid lauric, in acid palmitic, in acid linoleic and in acidα-linolénique however the contents in stearic acid, in acid palmitoléic and in oléique acid increased significantly in the germinated flour that in the fermented flour in the threshold 0.05 %. The germinated flour F_3 and the fermented flour F_B contain essential fatty

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY
ISSN-2319-2119
RESEARCH ARTICLE
Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

acids. The composition in fatty acids of the germinated flour was higher in polyunsaturated fatty acid and the mono unsaturated as regard to the fermented flour. This light increase could be in not conversion of the free fatty acidity carbohydrates which can lead to increase in the composition of fat during the germination (Onuoha *et al* 2006). Essential fatty acids (acid α linolénic and linoleic) are good quality fatty acids nutritional. These fatty acids are nutriments very important for the neuro sensory development of the infant. These present fatty acids in flours of weaning influence the health of the infant, by playing a role in the etiologic of a large number of pathologies.

Microbiological characteristics of composite flour germinated and fermented F_3 and F_A

The results show that the germinated flour contents 2.10^3 UFC/g GAM and the fermented flour 3.10^4 UFC/g GAM, these results respect the standards of the OMS. The other germs such as the total coliforms, E coli, the yeasts and the moulds sulfito – reducer; salmonella are absent in the flours (Table 6). The microbiological analyses show that germinated and fermented flours is unhurt of any germs: Flours do not contain pathogenic germs susceptible to have repercussions on the health of the infant. The microbiological quality of the flours (germinated and fermented) is very satisfactory because all the enumerations are lower than the Standards of the FAO (2006) with absence of salmonella. The acidity of the flour fermented (pH = 4.30) don't favour the development of the pathogenic microorganisms. The analysis microbiology reassures as for the hygienic quality of elaborate flours. It is necessary to keep these flours in the best conditions to avoid the contaminations which can arise afterward.

Sensory characteristics of porridges to the composite flour germinated and fermented

Porridges prepared from the germinated flour F_3 and the fermented flour F_A underwent a sensory evaluation by a hedonic test in 5 points and they were compared with the characteristics of the porridge of Cerelac (commercial flour Nestlé).

Taste

The tasters affected average notes of 4.35 ± 0.15; 4.3 ± 0.2 and 4.45 ± 0.1 respectively for the porridge of the germinated flour; the porridge of the fermented flour and that of the flour of Cerelac (commercial flour Nestlé). The values indicate that there is no significant difference in the threshold $P \leq 0.05$. These various porridges have the same taste (figure 1).

Colour

The average values of the colour of porridges 4.15 ± 0.10; 4.20 ± 0. 2; 4.85 ± 0.5 represent the appreciation of the tasters respectively for the porridges of the germinated flour, the fermented flour and the Cerelac flour (commercial flour Nestlé). There is no significant difference at the threshold of $P \leq 0.05$ for these various values (figure 1).

Aroma

The tasters accepted the porridge of germinated flour and the porridge of the flour of Cerelac; the average values of these porridges are respectively 4.3 ± 0.1 and 4.65 ± 0.35. There is no significant difference at the threshold of $P \leq 0.05$ for these various values (figure 1). However, the tasters did not all appreciate the aroma of the fermented porridge; the average value of the aroma of the fermented porridge is 3.85 ± 0.2 differ significantly at the threshold of $P \leq 0.05$.

Acceptability

The order preference porridges is the porridge of Cerelac, the porridge of germinated flour and the porridge of flour fermented (figure 1). There is no significant difference between porridges at the threshold of $P \leq 0.05$. The organoleptic qualities (taste, colour, and aroma) infantile flours influence their acceptability (Besançon, 1999). As far as it is them others who decide to buy or to use flours to feed their children, raw materials used for their manufacturing have to allow them to have organoleptic qualities which satisfy not only the children but also their mothers. The order decreasing rather porridges is the porridge of cerelac, the porridge of germinated flour and the

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE
Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

porridge of fermented flour. There is no significant difference between porridges at the threshold of $P \leq 0.05$. The organoleptic tests of porridges of germinated flour and fermented flour are comparable to those some porridge of Cerelac. These results are in agreement with those of Achi (2005) who presents the fermentation and the germination as traditional ways of enrichment and improvement of the nutritional and organoleptic quality of the infantile food.

Conclusion:

The fermentation and germination flours of the cereals (maize, sorghum, soybean) as a potential source to improve the nutritional qualities of the local staple cereal production. These food materials were purposely selected because of their availabilities locally and also to complement one another to obtain a balanced amino acid profile.These flours could contribute to fight against the infantile malnutrition. These results suggest the need of further studies about the possibility of using fermented and germinated cereals flours in food industry.

Table 1: Chemical composition of maize, sorghum, soybean and germinated maize, sorghum, soybean.

	Ingredients					
Nutrients (g/100g MS)	Maize	germinated Maize	Sorghum	germinated Sorghum	Soybean	Germinated Soybean
Carbohydrate	75 ± 0.5^a	66.5 ± 0.5^b	74.30 ± 0.1^a	67.25 ± 0.1^b	35.5 ± 0.5^c	30.5 ± 0.5^d
Starch	62.5 ± 1^a	26 ± 1.5^c	$60.5 \pm 0{,}5^a$	$28.7 \pm 0{,}3^c$	32 ± 1.5^b	20.3 ± 0.4^d
Cellulose	2.8 ± 1.1^b	$2{,}5 \pm 0.4^b$	2.6 ± 1^b	2.3 ± 0.3^c	3.4 ± 0.2^a	2.7 ± 0.3^b
Protein	9.6 ± 0.2^c	10.5 ± 2^b	10.9 ± 0.1^b	$11 \pm 0{,}5^b$	40 ± 0.5^a	42.8 ± 0.6^a
Fat	4.8 ± 1^c	7.9 ± 0.2^b	4.3 ± 0.2^c	6.6 ± 0.1^b	18.3 ± 0.5^a	19.5 ± 1^a
Ash	1.5 ± 0.2^d	2.5 ± 0.5^b	2 ± 0.3^c	2.8 ± 0.1^b	3.5 ± 0.2^a	4.5 ± 0.2^a
Minerals (mg/100g)						
Potassium	324.8 ± 0.5^b	345 ± 0.3^b	350 ± 0.1^a	380 ± 0.5^a	140.5 ± 0.2^d	180 ± 0.5^c

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY
ISSN-2319-2119
RESEARCH ARTICLE
Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

Phosphorus	299.6±0.1[c]	185±0.5[e]	287±0.2[c]	200±0.2[d]	480±3.0[a]	350±0.1[b]
Calcium	45±0.1[b]	50±1.1[b]	38±1.1[c]	40±0.5[c]	75±0.1[a]	80±0.5[a]
Magnesium	58±0.5[b]	60±0.2[b]	54±0.3[d]	56±0.4[c]	45±1.1[e]	120±0.2[a]
Sodium	38±0.2[b]	40±0.1[a]	30±0.4[d]	35±0.5[c]	39.5±1.1[a]	42±0.3[a]
Zinc	1.4 ± 0.1[e]	1.74 ± 0.5[d]	2.3 ± 0.2[c]	3.15 ±0.3[b]	2.5 ± 0.1[c]	4.2 ± 0.2[a]
Iron	2.5 ± 0.1[d]	2.8 ± 0.5[d]	4.2 ± 0.1[c]	4.6 ± 0.2[c]	5.5 ±0.2[b]	6.5±0.1[a]

Values are mean ± standard deviation of three measurements (n =3). The same letter in the same line index indicates that there is no significant between samples for the parameter concerned ($p \leq 0, 05$).

Table 2: Characteristics physicochemical of porridge from the germinated and fermented flour

Formula	Characteristic of porridges			
	Fluidity (mm/30sec)	Dry matter (%)	Protein (%)	Energy density (Kcal/100 ml)
germinated flour F_3	120	30.6	15.80	122.4
fermented flour F_A	90	22.67	15.17	90.68

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE
Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

Table 3: Chemical composition of the germinated flour and the fermented flour

Nutrients (g/100g)	Flour (g)		
	Germinated F_3	**Fermented F_A**	**Standard (g/100g) UNICEF (1998)**
Dry matter	95 ± 1^a	94.5 ± 1.5^a	95
Carbohydrates	69.20 ± 0.8^a	68.50 ± 0.5^a	68
Starch	61.5 ± 0.5^a	62.5 ± 0.5^a	64
Fat	7.5 ± 0.5^b	4.5 ± 0.5^a	8
Protein	15.80 ± 1.4^a	15.17 ± 0.83^a	15
Cellulose	4 ± 1^a	3.5 ± 0.2^a	3.8
Ash	2.8 ± 0.5^a	2.6 ± 0.5^a	2.9
Energy (kcal/100g)	402.37 ± 2.63^b	375.12 ± 0.5^a	400

Values are mean ± standard deviation of three measurements (n =3). The same letter in the same line index indicates that there is no significant between samples for the parameter concerned ($p \leq 0, 05$).

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE
Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

Table 4: Essential amino acids of composite flours

Essential amino acids (mg/g proteins)	Germinated flour F_3	Fermented flour F_A	FAO / WHO Standards (2006)
Histidine	25±1[a]	27±1[a]	26
Threonine	40 ±0,5[a]	48±1[b]	43
Lysine	51 ±0,5[a]	78 ±0,2[b]	63
Isoleucine	47 ±0,7[a]	49 ±0,2[b]	51
Leucine	76 ±0,5[a]	88±1[b]	94
Phenylamine + Tyrosine	69 ±0,2[a]	67 ±0,8[a]	87
Cystine + méthionine	36 ±0,3[a]	45 ±1[b]	35
Tryptophan	15 ±0,5[a]	19±1[b]	18
Valine	51 ±0,5[a]	60 ±0,7[b]	50

Values are mean ± standard deviation of three measurements (n =3). The same letter in the same line index indicates that there is no significant between samples for the parameter concerned (p $\leq$ 0,05).

Table 5: Fatty acids in germinated and fermented flours

Essential fatty acids g / 100g	Germinated flour F_3	Fermented flour F_A
Caprylic acid	3,3 ± 0,1[a]	2,8 ± 0,1[a]
Lauric acid	1,1 ± 0,1[a]	1,5 ± 0,3[a]
Myristic acid	10,5 ± 0,5[a]	12 ± 1[a]
Palmitic acid	30 ± 1[a]	35 ± 1[b]
Linoleic acid	16,5 ± 0,5[a]	15 ± 1[a]
Stearic acid	14,2 ± 0,2[b]	12,30 ± 0,3[a]

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY
ISSN-2319-2119
RESEARCH ARTICLE
Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

α-linolénic acid	$3{,}8 \pm 0{,}3^a$	$3{,}5 \pm 0{,}1^a$
Palmitoleic acid	$18{,}20 \pm 0{,}2^b$	$16{,}5 \pm 0{,}5^a$
Oleic acid	$2{,}4 \pm 0{,}1^b$	$1{,}4 \pm 0{,}1^a$

Values are mean ± standard deviation of three measurements (n =3). The same letter in the same line index indicates that there is no significant between samples for the parameter concerned ($p \leq 0{,}05$).

Table 6: Analyze microbiology of the germinated flour F_3 and the fermented flour F

Microorganisms	Germinated flour F_3 (UFC/g)	Fermented flour F_A (UFC / g)	Flours Standard (UFC / g)
GAM	$2.\ 10^3$	3.10^4	$<10^6$
Coliform	absent	absent	$<10^3$
E. coli	absent	absent	<100
Yeast	<10	<10	<1000
Mould	<10	<10	<1000
Salmonella	absent	absent	absent
Sulfito reducer	absent	absent	absent

ISSN-2319-2119

RESEARCH ARTICLE

Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

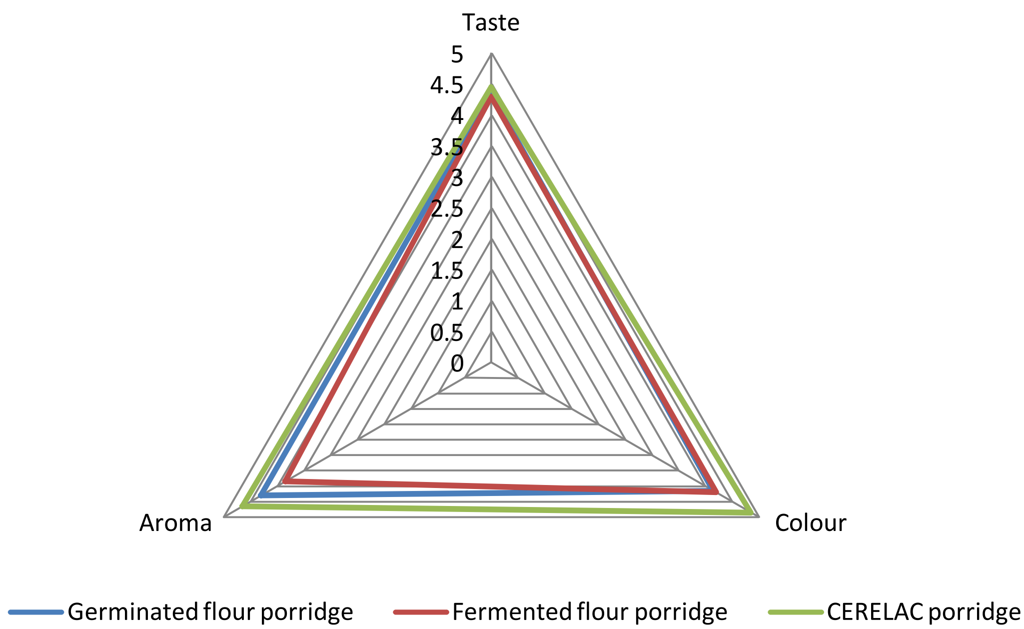

Figure 1: Sensory Profile of porridges

Bibliography

1. AOAC, 1995.*Méthodes d'analyses officielles*, 16ème édition Révisée .Association des Officiels Analytical Chemists,Washington D C.
2. ACHI, OK. The upgrading of traditional fermented foods through biotechnology. *In African Journal of Biotechnology*, vol. 4, 2005, p. 375-380.
3. Atwater W.O, Benedict F.G. Experiments on the metabolism of matter and energy in the human body. United States. Office of experiment stations bulletin N° 109 Government printing office 1902, Washington DC.
4. Blandino, A., Al-Aseeri, M.E., Pandiella, S.S., Cantero, D., Webb, C. (2003). Cereal-based Fermented foods and beverages. *Food Research International* ,36, 527-543.
5. Besançon P. Safety of complementary foods and bioavailability of nutrients. In Dop M.C., Benbouzid D., Trèche S., of Benoist B., Verster A ., Delpeuch F., éd.: Complementary feeding of young children in Africa and the middle-East, Geneva, World Health Organization ; 1999. 59-73 P.
6. Bertrand G, Thomas P. Guide pour les manipulations de chimie biologie. *Paris Dunod et Pinat* ; 1910. 468
7. BIPEA. Recueil des méthodes d'analyses des communautés européennes. Bureau interprofessionnels d'études analytiques Gennevilliers. France ; 1976. 140 p.
8. Dubois M, Gilles FK, Hamilton JK, Rebers PA, Smith F .Colorimetric Method for determinations of sugars and Related Substances. *Anal. Chem* ; 1956, Vol 28, N^0 3, pp 350-356.

ISSN-2319-2119

RESEARCH ARTICLE
Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

9. Cohen, S. A., Strydom, D. J. Amino acid analysis utilizing phenylisothiocyanate derivatives. Analytical Biochemistry; 1988. 174, 1-16.
10. Coulin F, Farah Z, Assanvo J, Spillman H, Puhan Z. Charaterization of the microflora of attieke. *International Journal of Food Microbiology;* 2006, 186, 131-136.
11. Eka, BE. Abbey, BW. Akaninwor, JO. Nutritional Evaluation of Some Traditional Weaning Foods from AkwaIbom State, Nigeria. In Nigerian Journal of Biochemistry and Molecular Biology; 2010; vol.25, n°1, p. 65-72.
12. FAO / WHO. Mixed programme FAO / WHO on the food standards. Reportof the twenty-seventh session of the committee ofthe codex on the nutrition and the dietary food; 2006. 105 p.
13. FAO. Targeting for nutrition resources for advancing well-being. Rome: Food and Agricultural Organization, UN. Geneva. www.fao.org/DOCREP/004/Y1329E/y1329e00.htm.2001.
14. Ghavidel, R.A. the impact of germination and dehulling on nutrients, antinutrients, in vitro iron and calcium bioavailability and in vitro starch and protein digestibility of some legume seeds. 2006. Dept of studies in *food science and nutrition*, Jamuna Prakash, University of Mysore,India.
15. Iwe MO, Onuh JO. Functional and Sensory properties of soybean and sweet potato flour mixtures. Lenbenson, Wens U Technol., 1992; 569 – 573.
16. Kaushick G, Satya S, Naik SN. Effect of the technical production of treatment(processing) on the nutritional quality of the Soya. Mditerr. *J.Nutri. Metab* ; 2010; 3 (1), 39-46.
17. Khatoon N, J.Prakash. The retention of the nourishing elements in legumes germinated cooked. *J.Agric. Chem alimentary ;* 2006. 97 (1), 115-121.
18. Muhimbula, HS. Issa-Zacharia, A. Kinabo, J. Formulation and sensory evaluation of complementary foods from local, cheap and readily available cereals and legumes in Iringa, Tanzania. In African *Journal of Food Science;* 2011, vol.5, n°.1, p. 26 –31.
19. Mouquet, C, Greffeuille, V, Trèche, S. Characterization of the consistency of gruels consumed by infants in developingcountries: Assessment of the Bostwick consistometer and comparison with viscosity measurements and sensory perception. International *Journal of Food Sciences and Nutrition ;* 2006 ; 57, 459-469.
20. Moursi M., Mbemba F., Trèche S. Does the consumption of amylase-containing gruels impact on energy intake and growth of Congolese infants? *Public Health Nutrition*; 2003; 6 (3), 249 - 257.
21. Malleshi, N.G., Daodu, M. A. and Chandrasekhar, M. L . Development of weaning food formulations based on malting and roller drying of sorghum and cowpea. *International Journal of Food science and Technology*; 1989, 24: 511- 51.
22. Mouquet, C, Bruyeron, O, Trèche, S. Caractéristiques d'une bonne farine infantile.In : les farines infantiles. *Bulletin du réseau Technologie et Partenariat en Agroalimentaire ;* 1998 N°15, 8-11.
23. Onuoha LN, Afam-Anene OC. Nutritional and functional properties of sesame. *Nig. J. Nutr. Sci ;* 2006 ; 27, 16-21.
24. Omueti, O. - Otegbayo, B. - Jaiyeola, O. - Afolabi, O.Functional properties of complementary diets developed from soybean (Wisteria max), groundnut and crayfish (Macro brachium SPP). InEJEAFC, tome 8, 2009, n° 8, p 563-573.
25. Syed, Have. - Aurang, Z. - Tariq, Mr. - Nadia, N. - Sayed, JA. - Muhammad, S.-Abdul, Has. – Asim. Effects of sprouting time one biochemical and nutritional qualities of Mung beanvarieties. In African *Journal of Agricultural Research*, tome 6, 2011, no 22, p 5091-5098.
26. Sanni A. I., Onilude A. A., Ibidapo O. T.. Biochemical composition of infant weaning food fabricated from fermented blends of cereal and soybean. *Food Chemistry*, 1999; 65, 35–39.

ISSN-2319-2119

RESEARCH ARTICLE
Kunimboa et al, The Experiment, 2015., Vol. 34(3), 2137-2149

27. Vieu M.C, Trèche S. Effetcts of energy density, and sweetness of gruels on Burkinabe infant energy intakes in free living conditions. Int *.J. Food .Sci. Nutr ;* 2001*; 52*: 213-218 p.
28. World Health Organization (WHO).Complementary feeding of young children.Report of a technical consultation supported by WHO, UNICEF, 1998; University of California/Davis and ORSTOM. 28-30 November 1995, Montpellier France.
29. Wang N., Hatcher D.W; Gawalko E.J . Effect of variety and processing on nutrients and certain anti-nutrients in field peas (*Pisum sativum*), *Food Chemistry*. 2008; 111: 132-138.
30. Wallace H, Andrews, Russell S. Flowers John Silliker,& J.Stan Bailey, 2001. Salmonella. In: Microbiological Examination of Foods, (Eds. PF Downes, K Ito), American Public Health Association, Washington,D.C, pp. 357-376.

Authors & Affiliation

Kunimboa * Abro Amoin Angèle Kouassi, Gnahé Dago André,
Serge Gbocho Ekissi Elvis , Agbo Adouko, Gnakri Dago.
Université Nangui Abrogoua, Laboratoire de Nutrition et de Sécurité Alimentaire, 02 BP 801 Abidjan 02, Côte d'Ivoire.
Université Jean Lorougnon Guédé de Daloa, BP 150 Daloa, Côte d'Ivoire.
Ivory Coast, Zip Code: 00225