The Effect of Malting On Sorghum and Maize for Weaning Food Production

[1]Ajobiewe A. M*., [2]Olorunsogbon B.F. and [3]Alaba J.O.

1. Department of Food Technology, The Federal Polytechnic, Ilaro, Ogun State.
2. Department of Agricultural Technology, The Federal Polytechnic, Ilaro, Ogun State.
3. Department of Food Science and Technology, Wesley University, Ondo, Ondo State.

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Abstract

The study focused on the effect of malting sorghum and soaking of maize for weaning food with a view to producing an affordable and nutritious complementary food for low – income families. Seven formulations were prepared as sample A to G. The samples were subjected to proximate, functional, anti – nutritional factors and sensory evaluation. The result from proximate analysis showed that the moisture content ranges from 8.36±0.21 to 8.70±0.21. Sample B has the highest moisture content of 7.80±0.57 and sample E has the lower moisture content of 8.70±0.21; sample F has higher protein content of 13.73±0.015 while sample C has the lower protein content of 9.09±0.14. The carbohydrate content ranged from 72.17 – 73.98, sample G has the highest carbohydrate content of 73.98. The Energy value ranges from 343.64 – 386.57; sample C has the highest energy value of 386.57 while sample B has the lowest content of energy value of 343.64. The result of functional properties of the samples shows that the pH of the samples ranged from 4.17 – 5.68. In which sample B has the highest pH of 5.68 and sample B has the lower pH of 4.17. The anti-nutritional analysis shows that sample B has a higher content of tannin of 14.33^c and sample A has the lower tannin content of 5.56^a. The tasters found the samples acceptable in terms of appearance, taste, flavor, texture and aroma when compared with homemade. In conclusion, the study has shown that a cheap and nutritious complementary food could be produced from sample F.

Keywords: malting, soaking, nutritious, proximate, functional, anti-nutritional, sensory evaluation.

INTRODUCTION

Cereals grains belong to the graminaea family and they are cultivated for their edible components. They are grown in greater quantities and provide more Food energy worldwide than any other type of crops. They are therefore referred to as staple crops. In their natural form (as in whole grain) they are rich source of vitamins, minerals, carbohydrate, fats & oil and protein (Belton and Taylor, 2002). Cereals are used in the production of common foods in Nigeria, such as Ogi, Tuwo and Quaker, corn flakes, custard, and also used in brewing industries for alcoholic and non – alcoholic beverages. Meals produced from maize are suitable for human consumption with or without further cooking and they are usually eaten weaning food such as ogi.
Weaning has been described as the gradual substitution of the mother's milk with solid and semi – solid food in infant's diet in order to fulfill their growing needs. It is a process starting with the introduction of complementary foods and ending with the complete cessation of breastfeeding. Many mothers especially in developing countries breastfeed for 12 months while others breastfeed for up to 24 month (kazim, and Karim, 1979; Adenuga 2010). It is a food, made more or less from processed grain, usually use in feeding babies at the age of 6 -12 month. It is often served hot, usually mixed with milk (e.g. soya milk, cow's milk almond milk.) water or yoghurt and sometimes fruits but, while some cereals such as oatmeal may be served hot.

Weaning is the substitution of solid foods or special childhood foods or breast or bottled milk. The weaning period is thus defined as the total period during which breast milk is being replaced by any other foods. Proper weaning foods should supply certain vitamins and minerals not present in breast milk, while providing additional calories. However, with the addition of food other than breast milk in the developing countries, there is a marked increase in the danger of gastroenteritis as a potential fatal disease. During weaning, the infant living in an overcrowded, unhygienic environment is at risk of developing acute diarrhea disease with its debilitation, and nutritional hazards, directly or indirectly leading to death.

Ogi is a common weaning food among the Western and Eastern parts of Nigeria than Southern part. It is an example of traditional fermented food, which has been upgraded to a semi –solid scale (Achi, 2005). It is a product of maize and sorghum, which is prepared by steering of grinded maize in boiled water until it becomes semi – solid fluid. The same preparation goes to sorghum, only that sorghum is steered in boiled water for a longer period than that of maize. Maize and sorghum are not good sources of protein, but sorghum has better protein content than maize but with poor digestibility. Gelatinized ogi is called pap and this is mainly used as a traditional infant weaning food as well as breakfast meal for many adult. This slurry absorbs a large quantity of water and swells up greatly when mixed with either cold or hot water. The foods are therefore bulky due to the high viscosity. Due to the fact that high bulk reduces food intakes by the child, it is often result in malnutrition. This can be solved by the protein complementation, a term which describes the combination of protein from different food sources (Inyang and Idoko 2006).

Malt is germinated cereals grains which have been dried in a process known as malting. The grains are made to germinate by soaking in water and are then halted from germinating further; this is achieved by drying with hot air. Malting grains develop the enzymes required to modify the grain's starches into sugars including monosaccharide such as glucose or fructose and disaccharides such as lactose, sucrose or maltose. It also develops other enzymes, such as protease, which can be used by yeast. Therefore, malting of sorghum improves both the protein quality and digestibility. Also, malting reduces anti – nutritional factors and increases soluble sugar.

MATERIALS AND METHODS

Maize and sorghum were purchased at the local market in Ondo, Ondo state, Nigeria. The preparation of weaning food (Ogi or Akamu) maize were cleaned, washed thoroughly and soaked in water for 3 days while the soaked water was changed over time. It was wet milled and sieved through muslin cloth. The filtrate was allowed to settle down; the water was discarded after which the semi – solid was dried in the cabinet dryer at a temperature of 50^0C for 2hrs. These are known as Ogi flour which was then packaged for further analysis. Malted sorghum was prepared with sorghum grains cleaned, immersed in water and washed twice during which glumes and chaff was removed. The water was drained off. First steeping took place for 6 hours after which it was drained and aerated for 3 hours. The same goes for the second steeping. The third steeping began by adding fresh water and was also steeped for 6 hours. The liquor was drained while germination process begins to take place which lasted for four days at room temperature. After the 4^{th} day of germination, the green malt was aerated for 4hrs and transfer into the cabinet dryer for drying; this process was to stop the growth of the green malt at the end of germination. This was agitated in the dryer at 24hrs interval. After drying, it was milled and packaged.

Table 3.1 Formation of weaning food from soaked maize flour and malted sorghum flour.

Samples	Maize flour	Sorghum flour
A	100	0
B	0	100
C	10	90
D	20	80
E	30	70
F	40	60
G	50	50

A ---- 100% soaked maize, B ---- 100% malted sorghum, C ---- 90% malted sorghum, 10% soaked maize, D ---- 80% malted sorghum, 20% soaked maize, E ---- 70% malted sorghum, 30% soaked maize, F ---- 60% malted sorghum, 40% soaked maize and G ----50% malted sorghum, 50% soaked maize.

Proximate analysis

The proximate analyses of the formulated samples were carried out using the standard procedure of Association of Analytical Chemist (AOAC, 2002). Carbohydrate content was determined by subtracting the value of the analyzed components i.e. Moisture content, protein, crude fat, ash content, crude fibre, from 100%, and was expressed in percentage. 100 - % (crude Protein + total ash + crude fibre +crude fat +Moisture content). Energy value was determined by a standard calculation using Atwater factor.

Protein x 4 joule / g + carbohydrate x 4 joule / g + Fat x 9joule /g

Physical Properties determination

The following physical properties were determined; pH, least gelation, swelling capacity, bulk density, Water absorption capacity, Oil absorption capacity.

pH

The pH was measured by making 1% W/V suspension of the sample in distilled water. The suspension was mixed thoroughly and the pH was measured with a combo pH meter (model HI 98129, Hanna Instrument, Italia).

Least gelation capacity (LGC)

Least gelation capacity was determined by the method described by Coffman and Garcia (1977). Ten suspension of the flour blended (2%, 4%, 6%, 8%, 10%, 12%, 14%, 16%, 18%, and 20%) (W/V) in 5 ml of distilled water was prepared in the test tubes. The test tubes containing the suspension were heated in a boiling water bath (THELCO, model 83, USA) for 1h. The tubes and the content were cooled rapidly under running water, and then cooled further for 2hrs at 4^0C. Next, the tube was inverted to see if the content would fall or slip off. The least gelation concentration is that concentration when the sample from the inverted test tubes does not fall of slip off.

Swelling power and solubility index

Swelling power and solubility was determined by Takashi and Sieb (1988) method. It involves weighing 1g of flour blend sample into 50 ml centrifuge tube. Fifty ml of distilled water was added and mixed gently. The slurry was heated in a water bath at 70^0C, 80^0C,

90^0C, and 100^0C respectively for 15 min. During heating, the slurry was stirred to prevent clumping of the flour. On completion of 15 min, the test tube containing the paste was centrifuged at 3000 rpm for 10 min using centrifuge. The supernatant was decanted immediately after centrifuging. The weight of the sediment was taken and recorded. The moisture content of the sediment gel was therefore determined to get the dry matter content in the gel.

$$\text{Swelling power} = \frac{\text{weight of wet mass sediment}}{\text{Weight of dry matter in the gel}} \times 100$$

Solubility index (%) = Weight of dry solid after drying x 100

Bulk density

The bulk density was determined using Ukpaibi and Ndimele (1990). Ten grams of each sample was weighed and poured gently into 25ml measuring cylinder. The level of the sample in each cylinder was traced out in ml and the bulk density was calculated.

$$\text{Density} = \frac{\text{mass of sample}}{\text{Volume of sample in the cylinder}}$$

Water absorption capacity (WAC)

The water absorption capacity was determined at room temperature using a combination of the AACC (1995) method and those of Murkowski and Kozlowska (1981), and Sosulski (1962). Two grams of the sample was dispersed in 20ml of distilled water. The content was mixed for 30s at every 10mins using a glass rod and after mixing five times, centrifuged at 4000rpm for 20 min. the supernatant was carefully decanted and the content of the tube were allowed to drained at 45^0 angle for 10 min and then weighed. The water absorption capacity was expressed as percentage increase of the sample weight.

Oil absorption capacity (OAC)

The oil absorption capacity was determined at room temperature using a combination of the AACC (1990) method and those of Ruthkowski and Kozlowska (1981), and Sosulski (1962). Two grams of the sample was dispersed in 20ml of distilled water. The content was mixed for 30s at every 10mins using a glass rod and after mixing five times, centrifuged at 4000rpm for 20min. the supernatant was carefully decanted and the corner of the tube were allowed to drained at 45^0angle for 10 minutes and then weighed. The water absorption capacity was expressed as percentage increase of the sample weight.

Determination of tannin content

Gravimetric determination of tannin was done according to the method described by Makkar *et al*, (1996). Defatted samples 0.2g was weighed into a test tubes and the tannin was extracted in 0ml 70% acetone. It was then placed in iced water bath for 10min to allow for complete extraction of tannin. About 0.2ml of the filtrate was placed in test tube and made up to 1ml with distilled water; 2.5ml of 20% Na_2CO_3 and 0.5ml folin's reagent diluted 1:1 with distilled water were added and the content was mixed properly. The solution was incubated for 45mins at room temperature to develop color (blue color). Standard tannic acid solution ranging from 0.01-0.05mg/ml was also prepared, followed by the addition of 2.5ml Na_2CO_3 and 0.5ml folin's reagent. The absorbant of each samples was read at wavelength 700nm using a Corning Colorimeter 253, Corning Ltd, Essex, England, against a agent blank. The tannin content in each samples was deduced from the standard tannic curve.

Determination of Oxalate

The determination was done according to Day and Underwood (1986). 1g of the malted sorghum and the soaked maize samples were put into separate plastic bottle followed by the addition of ml of 0.1N H_2SO_4. The contents was mixed properly ad allowed to extract from 1hour with constant agitation using a mechanical shakers. This was then filtered and 25ml of the filtrate was related with 0.1 ml $KMnO_4$ while hot (80-90^0C) until a purple color is observed at the end point. The titre value was the multiplied by 0.9004 to give the result expressed as mg/g.

Determination of Phytate

Phytate was determined according to the method of Young and Greaves, (1990).

4g of the samples were soaked in 100ml; of 2% HCL for 3hours and then filtered. 25ml of the phytate was placed in the conical flask. A 5ml of 0.3% ammonium thiocynate solution was added as an indicator and 53.3ml of distilled water was also added to give it proper acidity. This was concentrated with standard $FeCI_3$ solution until a brownish yellow color persists for five minutes.

Phyate in mg / 100mg = titre value x 564.11

Sensory evaluation

The samples were reconstituted into paste, coded and served to ten number semi-trained panelist using nine point Hedonic scale. Each panelist was given codes samples and was asked to evaluate for appearance, taste, aroma, texture, and the overall acceptability of the sample. The hedonic rating scale of 1 to 9 where 1 = dislike extremely, 5 = neither like nor dislike and 9 = like extremely.

Statistical analysis

Results were statistically analyzed by ANOVA and the means separated by Duncan multiple change technique using SPSS 16 computer package.

RESULTS AND DISCUSSION

The result of the proximate analysis of the malted sorghum and soaked yellow maize are shown in Table 4.1. The moisture content of the samples ranged from (8.36±0. 21 to.8.70±0.21).The values show that 90% of malted sorghum blended with 10% of soaked yellow maize which is sample C had the highest moisture content 8.55±0.26 compare to 100% malted sorghum and 100% maize. The result indicated an increase in moisture content with increase in addition of malted sorghum. This moisture content is within the range

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speculated for weaning foods. Higher moisture content indicates increased in susceptibility to spoilage and thus reduces shelf life, the moisture content analysis done on this samples shows all sample exhibit good keeping quality and longer shelf life.

The total ash content gives an indication of the mineral composition of the samples. The ash content ranges from (0.23±0.11 to 1.25±0.12). The total ash content of the malted sorghum and soaked yellow maize shows that 100% of malted sorghum which as great improved by malting, the lowest ash content is malted sorghum flour with 50% of soaked yellow maize flour. Highest ash content indicates a higher mineral composition.

Crude fibre, the result shows that all samples contain crude fibre. The content fibre content ranges from 0.65±0. 10-1.15±0.06). The samples 100% of malted sorghum flour has 1.15 ± 0.06 of fibre content while malted sorghum flour of 50% blended with 50% of soaked maize flour has the lowest fibre content the maize was dehull during the processing. The low crude fibre of foods makes it more digestible for children (Adenuga, 2010) i.e. low fibre content food enhance nutrient digestibility.

Crude fat content of the samples ranges from (3.70±0.06-5.60±0.12). The value shows that 100% of malted sorghum flour has a lower fat content due to the fact that the production of the samples was malted. The fat content increased in soaked yellow maize flour due to the fact that the protein content in 100% of maize is higher than that of malted sorghum. When fat is much in a diet, it causes rancidity and hence spoilage of thee diets.

Protein content of the samples ranges from (9.09±0.14-13.73±0.08). The values shows that 90% of malted sorghum flour blended with 10% of soaked yellow maize flour has the lowest protein content of 0.09± 0.14 which was due to the fat that malted sorghum flour has a the high moisture content, and moisture content has an influence on the protein content. The protein content increases with the addition of soaked yellow maize flour to the malted sorghum flour. Protein is needed for growth and development by replacing worn – out tissues. When this is insufficient, it leads to malnutrition and death may occur when not treated. Therefore, the moisture content of any food composition must be dried to nearest minimum.

Carbohydrate and energy content, the value of the carbohydrate ranged from (72.17% - 75.52%). Sample 90% of malted sorghum flour has the highest content. The energy content is much more due to carbohydrate content. It is important to have an easily and readily digested carbohydrate than to avoid using protein as a source of energy, carbohydrates are energy giving food. Energy is needed by the babies to perform daily activities. In this work, soaked yellow maize flour as the highest protein content so it is advisable to take soaked maize. A balance meal contains the essential food nutrients in their correct proportion. The essential food nutrient includes carbohydrate, protein, fats as well as minerals, vitamins and water.

Table 4. 1. The proximate Composition of the Formulated diets

Sample	Moisture (%)	Ash (%)	Fat (%)	protein (%)	fibre (%)	carbohydrate	Energy (Kcal) (kj/g)
A	8.69±0.20	0.55±0.10	4.04±0.10	13.29±0.015	0.34±0.15	73.98	385.44
B	8.70±0.21	1.25±0.12	5.6±0.12	11.14±0.8	1.15±0.10	72.17	343.64
C	8.55±0.26	0.23±0.15	5.35±0.15	9.086±0.14	0.10±0.10	75.52	386.57
D	8.46±0.17	0.39±0.17	34.75±0.17	10.00±0.17	0.98±0.06	75.33	360.32
E	8.36±0.21	0.325±0.10	3.97±0.13	13.67±0.15	0.90±0.10	72.68	381.13
F	8.52±0.15	0.24±0.10	3.86±0.10	1373±0.08	0.65±0.06	73.16	362.12
G	8. 46±0.17	0.23±0.11	3.7±0.06	13±0.05	0.69±0.06	73.86	380.74

A ---- 100% soaked maize, B ---- 100% malted sorghum, C ---- 90% malted sorghum, 10% soaked maize, D ---- 80% malted sorghum, 20% soaked maize, E ---- 70% malted sorghum, 30% soaked maize, F ---- 60% malted sorghum, 40% soaked maize and G ----50% malted sorghum, 50% soaked maize.

4.2. Functional Properties analysis

The functional properties of determined are presented in table 4.2

The pH of the sample ranges from (4.17 – 5.68). Sample B has the higher pH of 5.68 and sample A has the lower pH of 4.1 i.e. the most acidic of the sample which is probably due to the effect of malting. Malting increases the acidity of food because of the action of the hydrochloric enzymes (Gernah *et al*, 2010).

The bulk density of the samples ranges from 14.50 – 15.87, sample D has the higher bulk density of 15.87 and the sample has the lower bulk density of 14.50. Reduction in the bulk density of sample C would be an added advantage in the preparation of supplementary food (Akubor and Obiegbuna, 1999: Adetuyi *et al*, 2009) low bulk density in food is desired where packaging is a serious problem (Ikujenlola, 2008)

The least gelation capacity of the sample ranges from 0.2 -2.4. Sample A has the higher least gelation capacity of 2.4 and sample B has the lower least gelation capacity of 0.02.

The swelling capacity (SC) ranges from 0.1 – 0.9. Sample B has the higher (SC) of 0.9 and Sample E has the lower (SC) of 0.1

The water absorption capacity (WAC) ranges from 2.5 – 3.2. Sample C and F has the higher (WAC) of 3.2 while Sample A has the lower (WAC) of 2.5 the reduction in the WAC of the sample A agreed with the findings of Tatsadjieu *et al*, (2004). Increase in temperature also increases the water absorption capacity.

The oil absorption capacity (OAC) ranges from 1.2 – 3.0, Sample E has the higher (OAC) of 3.0 and sample G has the lower (OAC) of 1.2

4.2 Physical Properties of the formulated diet.

Sample	pH (m/v)	Least gelation	W.A.C Ml	O.A.C ml	Swelling capacity (ml)	Bulk density (g / ml)
A	4.17	0.8	2.5	2.9	0.3	15.33
B	5.68	2.4	2.6	2.9	0.9	14.53
C	5.55	2.2	3.2	2.9	0.5	14.50
D	5.33	2.0	3.0	2.85	1.0	14.87
E	5.08	1.6	3.1	3.00	0.1	15.10
F	5.14	1.2	3.2	1.8	0.3	15.77
G	4.84	1.0	3.1	1.2	0.5	15.83

A ---- 100% soaked maize, B ---- 100% malted sorghum, C ---- 90% malted sorghum, 10% soaked maize, D ---- 80% malted sorghum, 20% soaked maize, E ---- 70% malted sorghum, 30% soaked maize, F ---- 60% malted sorghum, 40% soaked maize and G ----50% malted sorghum, 50% soaked maize.

4.3 Anti nutritional factor analysis.

The anti – nutritional factors determined are presented in Table 4.3.

The oxalate content ranged from 12.3- 21.67. Sample A contain higher content of oxalate 21.67 and sample B has the lower oxalate content 12.33, therefore the sample with the lower oxalate content should be consume mostly. The tanning content of the sample ranges from 5.67- 14.33, sample A has the lowest content 5.67 and sample B has the higher content 14.33. Therefore sample with lower tannin content should be used for weaning, because tannin inhibit the digestion and absorption of food (Oboh and Akindahunsi, 2003). The phyate content ranged from 21.00-31.33, Sample A has the lower phytate content of 21.00 and sample B has a higher content of 31.33, so, therefore sample A is more preferable for weaning child because of its lower content of phytate.

Table 4.3. Anti-Nutritional properties of samples

SAMPLE	OXALATE (mg/100g)	TANNIN(mg/100g)	PHYTATE(mg/100g)
A	21.67^{C}	5.6^{a}	26.33^{b}
B	12.33^{a}	14.33^{c}	31.33^{C}
C	19.67^{bc}	13.33^{c}	22.00^{a}
D	16.33^{b}	12.33^{bc}	20.33^{a}
E	17.67^{bc}	12.33^{bc}	21.33^{a}
F	18.00^{bc}	10.33^{b}	21.00^{a}
G	16.67^{b}	10.33^{b}	28.67$_{b}$

Values are means of triplicate reading with different superscript in the same column are significantly different ($P < 0.05$). A ---- 100% soaked maize, B ---- 100% malted sorghum, C ---- 90% malted sorghum, 10% soaked maize, D ---- 80% malted sorghum, 20% soaked maize, E ---- 70% malted sorghum, 30% soaked maize, F ---- 60% malted sorghum, 40% soaked maize and G ----50% malted sorghum, 50% soaked maize.

Sensory Evaluation

Ten member panels were used to evaluate the sample. The panels were semi – trained but consisted of consumers who were familiar with the sample. Selection was based on interest and availability. The samples were prepared by mixing 30g blended flour in 150ml cold water. This was brought to boil to obtain gelatinization and a tea spoon of sugar was added to obtain sweetness. The panel members were seated in an open, well – illuminated laboratory. They rated the sample based on appearance, texture, flavor, taste and appeal on 9 point hedonic scale, where 9 represented like extremely and 1, dislike extremely respectively. Overall acceptability was also determined.

Data for all parameters were reported as means of ten judgments. Analysis of variance was computed for each sensory attributes as shown in table 4.4 Based on the report given by the panelists, the most preferred meal sample were chosen from the wet –milled samples. Meal prepared from 50% of malted sorghum flour blended with 50% of soaked maize flour had the highest rating of about 8.60 while the samples made from 60% of malted sorghum flour blended with 40% soaked yellow maize flour had better ratings next to the samples.

Table 4.4 Result obtained from the sensory Evaluation of the samples.

samples attributes	A	B	C	D	E	F
Aroma	4.30	4.70	4.70	6.80	8.00	8.10
Taste	4.50	5.20	5.70	6.60	8.30	8.30
Texture	4.00	4.90	5.80	6.60	7.60	8.30
Appearance	3.80	3.70	5.30	6.30	8.00	8.30
Overall acceptability	5.80	5.80	7.00	7.50	8.10	8.60

A ---- 100% soaked maize, B ---- 100% malted sorghum, C ---- 90% malted sorghum, 10% soaked maize, D ---- 80% malted sorghum, 20% soaked maize, E ---- 70% malted sorghum, 30% soaked maize, F ---- 60% malted sorghum, 40% soaked maize and G ----50% malted sorghum, 50% soaked maize.

CONCLUSION AND RECOMMENDATION

Conclusion

Supplementary food formulations in this study were based locally available low – cost materials commonly consumed in Nigeria. The study has shown that malting has help the anti-nutritional factors in the food that can inhibit the activity of the essential needed in them.

Recommendation

Processing such as malting should be adopted in the preparation of weaning foods.

Food is processed in form; it should be dried to the minimum and from any form of moisture in order to extend the shelf life and not to alter any nutrient

Interval of water from soaked maize every 24hrs must be maintain, because this also help to known the amount of anti-nutritional factor in them.

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