Effect of malting on the amino acid profile of red and white / cream colored Bambara Groundnut Seeds' Flour

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ABSTRACT

The effect of malting on the amino acid profile of the red and white/cream cultivars of Bambara groundnut (BGN) seeds' Flour was studied. The malting process enhanced the values of the amino acids in the malted samples when compared with the control. The white /cream sample also had higher amino acid values than in the red coloured counterpart. Amino acid contents were enhanced between the range of 1.19% in Lysine and 30.0% in methionine for the red sample while the increase in amino acids of the white/cream seeds' flours ranged between 6.75% in lysine and 15.09% in methionine. The malting resulted in amino acid quantities that competed very favorably with the casein reference quantities. Malting is recommended as a method to enhance the amino acid profile of Bambara groundnut seeds' flour.

INTRODUCTION

Vigna subterranea L, Bambara groundnut (BGN) is a pulse with subterranean fruit set (Ndidi *et al.*, 2014). It is a legume specie of African origin, and therefore an important source of affordable alternative protein to poor resource people in many tropical countries (Ihekoronye and Ngoddy,1985) especially in Africa and Asia where they are prominently consumed, Fasoyiro et al it belongs to the Febaceae family and subfamily of faboidea (Bamishaiye *et al.*, 2011). It is extensively grown in Nigeria and stigmatized as poor man's crop (Barimaala *et al*., 1994). Although bambara groundnut is rated as an underutilized wild legume (Bhat and Karim, 2009), Fasoyiro *et al.* (2012) reports show that the crop is of great importance nutritionally and has the potential to boost food security. It contains sufficient quantities of protein, carbohydrates and lipid (Brough and Azam-ali, 1992; Brough *et al*., 1993; Massawe *et al*., 2005). Although it is credited with a good balance of essential amino acid especially lysine 6.8% and methionine (1.3%), Barimaala *et al*., 2000), Proteins from pulses are known to be of inferior quality. It is on record that Physical and chemical methods are often employed to improve certain qualities of legume foods. This is because of the presence of anti-nutritional factors such as lectins, saponin, haemaglutin, protease inhibitors, oxalate, goitrogen, phytates, trypsin inhibitor and tannin (polyphenolic compound), One of the mayor ways of utilizing legumes is through processing for improving legumes' quality. Among the methods employed for the said improvement are soaking, germination fermentation *etc*. (Bora, 2014). Based on the foregoing, this study was set out to ascertain the effect of malting process on the amino acid profile of BGN varieties.

MATERIALS AND METHODS

i. The white and red varieties of bambara groundnut (BGN) seeds used for this study were procured from Enugu main market, Enugu State, Nigeria.

ii. **PREPARATION OF RAW (UNTREATED) BAMBARA GROUNDNUT FLOUR**:

Twelve kilograms (12 kg) of each variety of the Bambara groundnut seeds (which had been thoroughly cleaned) was weighed out and used. The items cleaned off include foreign particles such as stones, sticks, pieces of strings, pod particles, weevil infested, rotten or off coloured seeds. The cleaned seeds were then milled using the commercial milling machine. About two kilograms of the cleaned seeds was used to clean the machine and later discarded while the remaining 10 kg was milled and used for analysis. The seeds were passed through the machine twice, and the "output" was sieved and the flour collected. For the third and last machine pass, the sieve over-flow was re-milled and sieved. The flour from this sieving process was mixed with the first flour (collected earlier) while the over flow was now regarded as chaff.

iii. **PREPARATION OF MALTED BAMBARA GROUNDNUT (BGN) FLOUR**:

The malted Bambara groundnut flour was produced following two main steps). The first step was the malting (soaking, spreading on malting flour till the germination of the soaked seeds and air-drying) of the cleaned red and white/cream coloured bambara groundnut seeds respectively. The method of Aykroyd and Doughty, (1982) was adopted for the red bambara groundnut seeds, however, the method was modified for success in the white/cream coloured bambara groundnut seeds. The second step was the milling of the malted red and white / cream coloured seeds.

Red BGN Seeds:

The healthy cleaned red BGN seeds were soaked in clean tap water for 48 hours with 1hr rest-time every 12 hours. After the soaking period, the beans (now about twice their original size) were heaped on a malting floor lined with wet and clean cotton material. The soaked seed were covered with another piece of cotton material. Water was sprinkled on the sprouting beans every 12 hours. With the radicle having grown to about 2.0 to 2.5 cm long (by the next 48 hours), the sprouting was terminated when the sprouting beans were spread for air drying.

White / Cream BGN Seeds:

From preliminary studies, the white/cream coloured (W/C) bambara groundnut seeds did not sprout by the method used for the red bambara groundnut seeds. Consequently the soaking periods of 9 hours, 12 hours, 24 hours and 48 hours were experimented on. Percentage sprouting was better with shorter periods of soaking. Heaping period was for the same 48 hours as per red BGN seeds. Whether or not sprouted, the BGN seeds were air/sun dried after 48 hours on the malting floor. However, fan was used for drying during the rainy season. The dried malted BGN seeds were later milled with the commercial milling machine at Ogbete market, Enugu, Nigeria.

RESULTS AND DISCUSSION

Amino Acid Profile of the Malted Samples

The amino acid profile of the malted BGN seeds' flour was recorded on Table 1. Lysine (Lys), histidine (Hist), arginine (Arg), aspartic acid (Asp), threonine (Threo), serine (Ser), glutamic acid (Glu), proline (Pro), glycine Gly), alanine (Ala), cystine (Cys), valine (Val), methionine (Meth), isoleucine (Iso), leucine (Leu), tyrosine (Tyr) and phenylalanine (Phe) were assessed. Tryptophan could not be assayed due to the (Benitzer, 1984) method used for the amino acids' determination. The method could not assess tryptophan. The values obtained for the various amino acids were generally higher in the malted white/cream BGN seeds than in the equivalent Red BGN seeds. These values ranged from 1.25% in valine to 16.21% in Glutamic acid, in the untreated (control) sample of red BGN flour to 1.36% in valine to 17.27% in glutamic acid in the malted red BGN flour. The counterpart flour i.e, the white/cream BGN flours had a range of 1.19% of valine to 16.89% in glutamic acid in the untreated (control) flour. The malted flour had 1.56% valine while the glutamic acid was 17.67% when compared with the values obtained for the untreated sample (control). Table 1 also shows the percentage increased due to the malting process in the two BGN varieties. Through the malting process, nutrients e.g., the proteins increased in the malted product. This may be attributed to some modifications where some specific amino acids increased or decreased in quantities due to soaking and germination processes. Again increase in protein may be attributed to changes in enzyme activates. Increase in protein or amino acid content could also be due to germination/sprouting or degradation of storage protein and, synthesis of new protein as well as synthesis of others materials.

Mobilization of storage nitrogen so as to produce the nutritionally high quality proteins for the young plants' development could be the reason for the types and qualities of proteins in malted products. Ultimately, malting improves the nutritional quality of the proteins by hydrolyzing them into absorbable polypeptides and essential amino acids, (Fasoyiro *et al.,* 2012). The essential amino acid (EAAs) was recorded on Table 2. The values of the EAAs obtained through the malting process and the EAA quantities of casein protein used as a reference (Steinke *et al.,* 1980) are recorded on Table 2. Lysine and methionine were 6.7% and 1.3% respectively. This agrees with the report of many researchers (Barimaala *et al.*, 2000), Aside the values for histidine, all the values obtained for the EAAs in the untreated (control) and the malted samples are lower than the values of the references casein protein. The percent increase of the EAAs obtained due to malting are enclosed in parenthesis, while the percentages of the EAAs when compared with the casein reference protein are indicated in a different column. In the red BGN seeds the malting process enhanced the EAAs (as can be seen in the malted flours) by between 1.19 % and 15.75 %. Leucine content was enhanced by 5.54 %; isoleucine was enhanced by 15.75 % while lysine was enhanced by 1.19 %. Methionine, threonine and valine were enhanced by 30.00 %, 2.94 % and 8.80 % respectively. Phenylalanine and histidine were not enhanced through malting.

Table 1
Amino Acid Composition of Untreated and Malted BGN Flours.

	Untreated Red BGN flours	Malted Red BGN Flour	% Increase Due to malting	W/C untreated (Control) BGN flour	W/C Malted BGN flour	% Increase Due to malting
Lysine	6.70^{c}±0.02	6.78^{b}±0.00	(1.19)	6.81^{b}±0.01	7.27^{a}±0.03	(6.75)
Histidine	3.06^{b}±0.00	3.00^{c}±0.01	-	2.90^{b}±0.02	3.34^{a}±0.04	(15.17)
Arginine	6.21^{c}±0.01	6.47^{b}±0.02	(4.19)	6.47^{b}±0.03	6.99^{a}±0.01	(8.04)
Aspartic Acid	11.3^{c}±0.03	11.91^{b}±0.00	(4.93)	12.00^{a}±0.04	11.9^{b}±0.02	(0.75)
Threonine	3.40^{c}±0.04	3.50^{b}±0.01	(2.94)	3.37^{c}±0.02	4.25^{a}±0.03	(26.11)
Serine	4.96^{b}±0.02	4.9^{b}±0.04	-	4.91^{b}±0.03	5.07^{a}±0.04	(3.26)
Glutamic Acid	16.21^{d}±0.00	17.27^{b}±0.00	(6.54)	16.89^{c}±0.01	17.57^{a}±0.01	(4.03)
Proline	3.87^{d}±0.01	4.37^{b}±0.03	(12.93)	4.07^{c}±0.02	4.58^{a}±0.00	(12.53)
Glycine	3.41^{c}±0.02	4.49^{a}±0.04	(12.81)	4.07^{b}±0.00	4.49^{a}±0.02	(11.06)
Alanine	4.10^{d}±0.03	4.79^{b}±0.02	(16.83)	4.60^{c}±0.01	4.94^{a}±0.03	(7.39)
Cystine	1.39^{b}±0.04	1.46^{b}±0.03	(5.04)	1.39^{b}±0.04	1.59^{a}±0.04	(14.39)
Valine	1.25^{c}±0.00	1.36^{b}±0.01	(8.80)	1.19^{d}±0.00	1.56^{a}±0.00	(31.09)
Methionine	1.30^{c}±0.01	1.69^{a}±0.02	(30.00)	1.46^{b}±0.03	1.69^{a}±0.02	(15.75)
Isoleucine	3.81^{c}±0.02	4.41^{a}±0.00	(15.75)	4.19^{b}±0.04	4.41^{a}±0.01	(5.25)
Leucine	7.40^{d}±0.03	7.81^{b}±0.01	(5.54)	7.73^{c}±0.02	8.00^{a}±0.03	(3.49)
Tyrosine	3.33^{c}±0.04	3.81^{a}±0.04	(14.41)	3.49^{b}±0.03	3.81^{a}±0.02	(9.17)
Phenylalanine	5.06^{b}±0.02	5.06^{b}±0.01	-	4.80^{c}±0.00	5.31^{a}±0.04	(10.63)

Values are means ± standard deviation (SD) from three (3) determinations. Means not followed by the same letters along the column are significantly different at $P \leq 0.05$ In the case of the white/cream BGN seeds' flour, the malting process resulted to higher enhanced values in the EAAs than in the untreated/control samples. Their percentage increases were 5.25% for isoleucine, 6.75% for lysine and 15.75% for methionine. Threonine, valine, phenylalanine and histidine had percentage increase of 26.11%, 31.09%, 10.63% and 15.17% respectively. Quantitatively, the white/cream BGN samples generally had higher values and percentages than the corresponding amino acids in the red BGN samples. However, the malting process enhanced methionine (sulphur containing amino acid) by as high as 30.00%. It may be safe to conclude that malting is a useful process to enhance the protein quality of the BGN seeds' flours thus confirming the earlier reports of some researchers including Aykroyd and Doughty (1982). Through the malting process, nutrients e.g, the proteins, increase in the malted product. This may be attributed to some modifications where some specific amino acids increase or decrease in quantities due to soaking and germination processes. Again increase in protein may be attributed to change in enjyme activates. Increase in protein content could also be due to because of germination/sprouting or degradation of storage protein and synthesis of new protein as well as synthesis of others materials.

Mobilization of storage nitrogen, producing the nutritionally high quality proteins for the young plants' development could be the reason for the types and qualities of proteins in malted products. In the case of the white/cream BGN seeds' flour, the malting process resulted to higher values in the EAAs than in the untreated/control samples. Their percentage increases were 5.25% for isoleucine, 6.75% for lysine and 15.75% for methionine. Threonine, valine, phenylalanine and histidine had percentage increase of 26.11%, 31.09%, 10.63% and 15.17% respectively. Quantitatively, the white/cream BGN samples generally had higher values and percentages than the corresponding amino acids in the red BGN samples. However, the malting process enhanced methionine (sulphur containing amino acid) by as high as 30.00%. It may be safe to conclude that malting is a useful process in enhancing the protein quality of the BGN seeds' flours thus confirming the earlier reports of some researchers including Aykroyd and Doughty (1982).

Table 2

The Essential Amino Acids' Content (In g/16gN) Of Untreated and Malted BGN Flours

Essential Amino Acid	¤Casein Ref Protein	Untreated Red BGN Flour	Malted Red BGN Flour	% Of casein ref protein	Untreated W/C BGN Flour	Malted W/C BGN Flour	% Of casein Ref protein
Leucine	9.5	7.40	7.81 (5.54%)	82.21	8.00	8.00	84.21
Isoleucine	5.4	3.81	4.41 (15.75%)	81.48	4.19	4.41 (5.25%)	81.67
Lysine	8.5	6.70	6.78 (1.19%)	79.76	6.81	7.27 (6.75%)	108.51
*Methionine	3.50	1.30/*2.69	1.69/*3.15 (7.10%)	90.00	1.46/*2.85	1.69/*3.28 (15.09%)	93.71
Tyrptophan	-	-	-	-	-	-	-
Threonine	4.2	3.40	3.50 (2.94%)	83.33	3.37	4.25 (26.11%)	101.19
Valine	6.3	1.25	1.36 (8.8%)	21.59	1.19	1.56 (31.09%)	24.76
Phenylalanine	11.10	5.06/ Δ8.39	5.06/ Δ8.87 (5.72%)	79.91	3.29/ Δ4.80	5.39/ Δ9.12 (90.0%)	82.16
Histidine	2.4	3.06	3.00	125.00	2.90	3.00 (3.45%)	125.00

¤Casein reference protein Steinke *et al*. (1980)

***Methionine plus cystine = 3.50 Steinke *et al.* (1980)**

ΔPhenylalanine plus tyrosine = 11.10 Steinke *et al*. (1980)

Table 2 reveals the essential Amino acids content of the malted red and white/cream bambara groundnut seeds' flours. There were increases due to malting amounting to 5.54%, 15.75%, 1.19%, 17.10%, 2.94%, 8.8%, 5.72%, increase for Leucine, isoleucine, lysine, methionine, threonine, valine, and phenylalanine respectively. When compared with casein reference protein, lysine, threonine and histidine of white/cream malted flour, and histidine of the red BGN malted flour compared favourably. The white/cream BGN malted flour had more increases in its amino acid profile. Their percentage increases were 5.25%, 6.75, 15.09%, 26.11%, 31.09%, 90.00% and 3.45% for isoleucine, lysine, methionine, threonine, valine phenylalanine, and histidine respectively. Quantitatively, phenylalanine was mostly echanced for the white/cream variety while methionine was most enhanced in the red variety. Again, the range of 24.76% and 125% of the casein reference protein accrued due to malting in the white/cream BGN seeds' flour. Malting could be deemed a useful process for improving the protein quality in the BGN seeds.

CONCLUSION

Malting process enhanced the quantities of the amino acids concentration of the BGN flours, suggesting that this legume has the potential of alleviating protein malnutrition in the consumers especially in Africa.

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