AMINO ACID PROFILES AND CHEMICAL CONSTITUENTS OF WHEAT-COCOYAM-GROUNDNUT BISCUITS

Amanyunose, Aderonke A.[1*], **Abiose**, Sumbo H.[2], **Adeniran**, Hezekiah Adekanmi [2]and **Ikujenlola**, A. Victor [2]
[1]Department of Food Science and Technology, Osun State Polytechnic, Iree
[2]Department of Food Science and Technology, Obafemi Awolowo University, Ile-Ife
*E-mail: ronkeamanyunose@gmail.com

Abstract
Biscuits were produced from blends of wheat-cocoyam-groundnut flour formulated in the ratio wheat flour: cocoyam flour: groundnut flour: (100:0:0, 90:5:5, 80:10:10, 70:15:15, 60:20:20, 50:25:25, 40:30:30 and 30:35:35). The study evaluated the proximate composition, mineral content and amino acid profiles of the fortified biscuit.The protein content of the biscuit samples ranged from 13.54 to 30.50%. Among the samples, the highest protein content was recorded for sample H (30% wheat flour, 35% cocoyam flour and 35% groundnut flour) and the lowest protein content (13.54%) was recorded for 100% wheat biscuits.The calcium content of the biscuits ranged between 43.16 and 58.35 mg/100 g. The total amino acid content of all the fortified biscuit samples were higher than that of the 100% wheat biscuit samples. It was thus concluded that the biscuits produced from composites mix of wheat, cocoyam and groundnut had higher nutritive values.

Keywords: Biscuits, Amino acid, cocoyam, groundnut, wheat

Received: 29.06.2021 Reviewed: 10.09.2021 Accepted: 18.11.2021

1. INTRODUCTION

Biscuit traditionally produced from wheat flour is a popular snack item among school children in Nigeria. They are popular examples of baked product of ready-to-eat snack that have several appealing characteristics which includes extensive consumption, wide acceptability with long shelf-life and have the ability to serve as a means for important nutrient addition (Ajibola *et al*., 2015). Due to increase in the demand for bread and other pastries produced from wheat flour in tropical countries, huge amounts of foreign exchange are spent on wheat importation annually in these countries (Ohimain, 2014).
Nigeria wheat importation is growing at the rate of 13% per year and and could reach 17 million metric tonnes by 2020 (Olanrewaju, 2012). These challenges are being solved by food producers by sourcing for alternative raw materials indigenously grown that will meet the nutritional requirements of individuals and also reduce cost of wheat importation (Taiwo *et al*., 2017). Cocoyam is one of the important root food crops especially among low income earnersin Nigeria, its use however is limited to direct consumption through boiling of the tubers or used in thickening of soups especially in Eastern Nigeria (Ejoh *et al*., 2013).
Cocoyam has fine granular starch which has been reported to improve binding and reduce breakage of snack products (Huang, 2005). Potentials exist for the use of cocoyam flour especially when combined with legumes in pastry production. Defatted groundnut flour (DGF) produced from groundnut cake have been reported to enhance the nutritive value of wheat and other flour (Purohit and Rajyalakshme, 2011).
Despite the fact that DGF has an excellent potential in food formulations due to the high protein content, its use remains limited. Therefore, ways are continuously being sought to add value to this product through novel utilization (Ojokoh *et al*., 2014). The mix of groundnut, cocoyam and wheat flours in biscuit production will extend the utilization of cocoyam and groundnut flour while reducing the dependence on wheat importation for biscuit production.

2. MATERIALS AND METHODS

Materials

Cocoyams (*Xanthosoma* sp) and groundnut were procured from the Research Farm of Obafemi Awolowo University, Ile-Ife (OAU). Other materials used for baking such as wheat flour, sugar, milk, egg, and fat were purchased from a local market in Osogbo, Osun state. All chemicals used were of analytical grade.

Methods

Cocoyam flour production

Cocoyam flour was produced using the method described by Igbabul *et al*., (2014). The cocoyam tubers were washed to remove soil particles and other debris and then peeled. The peeled tubers were washed again, sliced into smaller pieces of 2.0 mm thickness using stainless steel kitchen knife and blanched at 80 °C for four minutes.

The blanched tubers were dried at 65 °C. It was then milled to obtain flour and sieved through a 100 μm mesh sieve. The flour was stored in air tight containers until required.

Groundnut flour production

Groundnut flour was produced according to the modified method described by Mgbemere (2011). Shelled groundnuts were roasted in the oven at 170 °C for 15-20 mins, allowed to cool and the skin was removed.

The roasted kernels were then milled and defatted using hydraulic press. The defatted cake obtained was disintegrated, sieved to obtain fine flour and packaged in cellophane bags until required.

Formulation of flour blends

Composite blends of wheat, cocoyam and groundnut flour were formulated in the following ratio: wheat flour: cocoyam flour: groundnut flour: (100:0:0, 90:5:5, 80:10:10, 70:15:15, 60:20:20, 50:25:25, 40:30:30 and 30:35:35) as shown in Table 1. The flour blends were mixed at maximum speed for 5 mins using a Kenwood blender. This was mixed together with other ingredients for biscuit production.).

Production of biscuit

The biscuit was produced using the method of Ceserani and Kinton (2008). The ratio of ingredients used for the preparation of biscuits is shown in Table 2. Fat and sugar were creamed to a smooth consistency; eggs and milk were then added and mixed thoroughly. The dry ingredients; flour and baking powder were mixed together and added to the cream followed by addition of vanilla flavour and nutmeg to form dough.

The resultant dough was placed on a floured wooden work table, kneaded and rolled out into uniform thickness and cut into round shapes with a biscuit cutter.

These were then placed in a greased pan and baked in a pre-heated oven at 185 ºC for 20 min. After baking, the biscuits were allowed to cool then packaged in low density polyethylene bags.

Table 1. Flour Blends Formulation

Sample	Wheat flour (%)	Cocoyam flour (%)	Groundnut flour (%)
A	100	-	-
B	90	5	5
C	80	10	10
D	70	15	15
E	60	20	20
F	50	25	25
G	40	30	30
H	30	35	35

Table 2. Quantity of Ingredients for Biscuit Production

Ingredients	Percentage (%)	Amount
Flour	40	100 g
Fat	18.7	40 g
Sugar	11.7	25 g
Egg	7	31 g
Milk	0.5	7.8 g
Nutmeg	0.2	0.3 g
Vanilla flavour	0.1	5.0ml
Salt	0.5	1 g
Baking powder	14.6	1 g

Ceserani and Kinton (2008)

CHEMICAL ANALYSES

Proximate Analysis

The proximate compositions of the samples were determined using AOAC (2006) methods.

Mineral Analyses

The analyses for essential mineral elements was carried out by Atomic Absorption Spectrophotometer (AOAC, 2005). About 0. 5g of the sample was weighed into 75 ml digestion flask and 5 ml digestion mixture (10ml HNO_3 and H_2SO_4) added and left overnight in a hood. It was then digested for 2 hours at 150 °C, and left to cool for 10 minutes. 3 ml of 6M hydrochloric acid was added and digested for another one and half-hours. This was allowed to cool and 30 ml of distilled water added. The tube was vigorously stirred. The digest was used to determine the minerals (calcium, magnesium, manganese, copper, iron and zinc) on the Atomic Absorption Spectrophotometer (Perkin Elmer, model 402). Sodium and potassium were determined by flame photometry while phosphorus was determined using the Vanodo-molybdate method.

Amino Acid Analysis

This was determined using the method described by Benitez (1989). About 500mg of sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Applied Biosystems PTH Amino Acid Analyzer. 50 µL of the hydrolysates was directly injected into the analyser. About 7 ml of 6N HCl was added and oxygen was expelled by passing nitrogen into the ampoule to avoid possible oxidation of methionine and cysteine during hydrolysis. The glass ampoule was then sealed with Bunsen burner flame and put in an oven pre-set at 105 ºC± 5 ºC for 22 h. The ampoule was allowed to cool before broken open at the tip and the content was filtered to remove the humins. Tryptophan was destroyed by 6N HCl during hydrolysis. The filtrate was then evaporated to dryness using rotary evaporator. The residue was dissolved with 5 ml to acetate buffer (pH 2.0) and stored in plastic specimen bottles, which were kept in the freezer. The amount loaded was 60 microliters. This was dispensed into the cartridge of the analyser. The analyser is designed to separate and analyse free acidic, neutral and basic amino acids of the hydrolysate. An integrator attached to the Analyser calculates the peak area proportional to the concentration of each of the amino acids.

Statistical analysis

The significant differences at 95% confidence level of the obtained experimental data were evaluated by analysis of variance using Duncan's multiple range test as post-hoc multiple comparison test (Odunlade *et al*., 2016).

3. RESULTS AND DISCUSSION

The moisture content of the composite biscuit samples, ranged from 7.45 to 9.32% (Table 3). The highest moisture content recorded was for the biscuits produced wholly from wheat flour (Sample A) while the lowest was from Sample H (30% wheat flour, 35% cocoyam flour and

35% groundnut flour). This is similar to moisture content reported by Igbabul *et al.* (2015) for biscuits produced from the blends of wheat, cocoyam and African yam bean flours which were in the range 8.54 to 10.68%. It was observed that the moisture content of the biscuits produced from the composite flour blends decreased with reduction in wheat flour and subsequent increase in the proportion of the other flour blends. Similar trend was reported by Kaushal *et al*. (2012) for blends of taro, rice and pigeon pea flour. The reduction in moisture content might be attributed to the varying binding/absorption capacity of the different food matrices of the flour blends used in the production of the biscuits.

The ash content of the composite biscuit samples (Table 3) ranged from 1.97 to 3.49%. The highest ash content (3.49%) was observed for the biscuits produced from sample H (30% wheat flour, 35% cocoyam flour and 35% groundnut flour). The ash content for the biscuit samples were found to be lower than 2.56 to 3.68% reported for biscuits produced from pigeon pea and cocoyam flour blends by Okpala and Chinyelu (2011) and 2.40 to 3.64% reported by Igbabul *et al*. (2015)for biscuits produced from varying mixtures of wheat, cocoyam and African yam bean flours.

The addition of cocoyam and defatted flours to wheat flour caused a significant increase in the ash content of the biscuits. This could be attributed to the differential and higher composition of ash of groundnut and cocoyam flours.

The fibre content of the composite biscuit samples ranged from 0.65 to 2.44%. The 100% wheat biscuits had the lowestfibre content (0.65%) which was lower than 2.45% and 1.44% reported by Ajibola *et al.* (2015) and Oyeyinka *et al.* (2014) for whole-wheat biscuits and wheat-plantain biscuits, respectively. The fibre content for the biscuit samples were found to be lower than the values (2.41 to 2.86%) obtained for biscuits produced from pigeon pea and cocoyam flour blends as reported by Okpala and Chinyelu (2011). It was however comparable with the range of values (1.63 to 2.42%) reported by Igbabul *et al*. (2015)for biscuits produced from flour blends of wheat, cocoyam and african yam bean. The fibre content obtained in this work are higher than 0.38 to 0.46% reported by Tyagi *et al.* (2007) for biscuits produced from the binary mixtures of wheat flour and mustard flour. The addition of cocoyam and defatted groundnut flour to wheat flour caused an increase in the fibre content of the biscuits.

Table 3. Proximate Composition (%) of Wheat-Cocoyam-Groundnut Composite Biscuits

Sample	Moisture	Ash	Fat	Protein	Fibre	Carbohydrate
A	9.32 ± 0.03^{a}	1.97 ± 0.02^{h}	11.18 ± 0.06^{d}	13.54 ± 0.04^{h}	0.65 ± 0.05^{h}	63.36 ± 0.17^{a}
B	8.95 ± 0.02^{b}	2.09 ± 0.02^{g}	10.75 ± 0.02^{f}	16.20 ± 0.03^{g}	0.89 ± 0.02^{g}	61.15 ± 0.13^{b}
C	8.40 ± 0.05^{d}	2.19 ± 0.04^{f}	10.34 ± 0.02^{g}	17.09 ± 0.02^{f}	1.06 ± 0.03^{f}	60.93 ± 0.13^{b}
D	8.24 ± 0.03^{e}	2.48 ± 0.01^{e}	11.14 ± 0.01^{d}	21.18 ± 0.04^{e}	1.48 ± 0.01^{e}	55.89 ± 0.07^{c}
E	8.47 ± 0.01^{c}	2.87 ± 0.02^{c}	12.13 ± 0.03^{c}	24.85 ± 0.03^{c}	1.85 ± 0.04^{c}	49.84 ± 0.14^{e}
F	7.45 ± 0.02^{h}	2.80 ± 0.02^{d}	11.01 ± 0.02^{e}	23.56 ± 0.03^{d}	1.77 ± 0.02^{d}	53.43 ± 0.10^{d}
G	8.01 ± 0.03^{f}	3.32 ± 0.03^{b}	12.46 ± 0.01^{b}	28.29 ± 0.03^{b}	2.19 ± 0.01^{b}	45.74 ± 0.11^{f}
H	7.64 ± 0.01^{g}	3.49 ± 0.03^{a}	12.66 ± 0.02^{a}	30.50 ± 0.05^{a}	2.44 ± 0.01^{a}	43.29 ± 0.11^{g}

Values are means of duplicate determinations ± standard deviation.
Mean values along the same column with different superscripts are significantly different ($p<0.05$)
A = 100% Wheat flour
B = 90% Wheat flour, 5% cocoyam flour and 5% groundnut flour
C = 80% Wheat flour, 10% cocoyam flour and 10% groundnut flour
D = 70% Wheat flour, 15% cocoyam flour and 15% groundnut flour
E = 60% Wheat flour, 20% cocoyam flour and 20% groundnut flour
F = 50% Wheat flour, 25% cocoyam flour and 25% groundnut flour
G = 40% Wheat flour, 30% cocoyam flour and 30% groundnut flour
H = 30% Wheat flour, 35% cocoyam flour and 35% groundnut flour

The fat content of the composite biscuit samples, ranged from 11.18 to 12.66% (Table 3). The 100% wheat biscuits had the lowestfat content (11.68%) which was similar to 11.75% reported by Youssef (2015) for wheat flour biscuit. It was however higher than the 3.01% reported by Igbabul *et al.* (2015) for cookies produced from composite mix of wheat, cocoyam and african yam beans.

The fat content obtained in this study are lower than 23.71 to 30.09% reported by Bolarinwa *et al.* (2016) for malted sorghum-soy biscuit and 13.19 to 15.00% fat content obtained by Ajibola *et al.* (2015) for *moringa* - cocoa powder whole wheat biscuits. It can thus be deduced that as the proportion of cocoyam and groundnut flour increased, the fat content of the biscuits increased significantly. This is not solitarily influenced by the groundnut and cocoyam flours but also by the ingredients such as milk and margarine used in producing the biscuits.

The protein content of the composite biscuit samples, ranged from 13.54 to 30.50% (Table 3). Among the samples, the highest protein content was recorded for sample H (30% wheat flour, 35% cocoyam flour and 35% groundnut flour) and the lowest protein content (13.54%) was recorded for 100% wheat biscuits. The protein content of the 100% wheat biscuit was higher than the 10.44% by Igbabul *et al.* (2015) for wheat biscuits.

The protein contents of the enriched biscuits were also found to be higher than 7.43 to 12.35% reported by Oluwamukomi *et al.* (2011) for wheat-cassava-soybean biscuits. Likewise, the values are greater than 10.45 to 14.73% presented by Igbabul *et al.* (2015) for wheat-cocoyam-african yam bean biscuits. It can thus be seen that as the proportion of cocoyam and groundnut flour increased, the protein content of the biscuits increased significantly.

A similar increase was reported by Ajibola *et al.* (2015) in the enrichment of whole wheat biscuits with *moringa* and cocoa powder.

The carbohydrate content of the composite biscuit samples ranged from 43.29 to 63.36% (Table 3).

There were significant differences ($p<0.05$) inthe carbohydrate content of the biscuit samples. Among the samples, the lowest carbohydrate content (43.29%) was recorded for sample H (30% wheat flour, 35% cocoyam flour and 35% groundnut flour) and the highest carbohydrate content (63.36%) was recorded for 100% wheat biscuits.

The decrease in carbohydrate content observed with addition of cocoyam and groundnut flours was similarly reported by Igbabul *et al.* (2015) and Oluwamukomi *et al.* (2011), respectively for wheat-cocoyam-african yam bean biscuits and wheat-cassava-soybean biscuits. These enriched biscuits are potential food that can reduce protein energy malnutrition and its symptomatic effects among the populace especially children.

Mineral Composition of Wheat-Cocoyam-Groundnut Biscuits

The result of the calcium content of biscuits are presented in Table 4. The calcium content of the biscuits ranged between 43.16 and 58.35 mg/100 g. It was observed that the calcium content of the biscuits samples significantly increased ($p<0.05$) with addition of cocoyam and defatted groundnut flours.

A similar increasing trend in calcium content was reported during the production of wheat sorghum date cookies (Taiwo *et al*., 2017). The magnesium content of biscuit samples ranged between 15.08 and 20.26 mg/100 g. This showed an increase of 2.12 to 34.35% for biscuits fortified with cocoyam and defatted groundnut flours. It was observed that the inclusion of cocoyam and defatted groundnut caused significant increases ($p< 0.05$) in the magnesium content of the biscuits.

Biscuit samples produced from composite flour of wheat and alfalfa seed flour followed similar trend, it was reported that with the incorporation of alfalfa seed flour into wheat flour from 0 to 20%, the magnesium content significantly increased from 14.65 to 26.64 mg/100 g (Ullah *et al*., 2016).

Table 4. Mineral Composition (mg/100 g) of Wheat-Cocoyam-Groundnut Biscuits

Sample	Calcium	Magnesium	Potassium	Zinc	Iron
A	43.16 ± 0.05[h]	15.08 ± 0.11[g]	94.88 ± 0.18[h]	1.03 ± 0.03[h]	3.32 ± 0.01[g]
B	44.59 ± 0.01[g]	15.40 ± 0.01[f]	104.97 ± 0.02[g]	1.23 ± 0.02[g]	3.47 ± 0.01[f]
C	45.31 ± 0.04[f]	15.51 ± 0.06[f]	106.07 ± 0.08[f]	1.31 ± 0.04[f]	3.58 ± 0.01[e]
D	48.65 ± 0.03[e]	16.95 ± 0.04[e]	121.58 ± 0.02[e]	1.60 ± 0.01[e]	3.61 ± 0.02[de]
E	52.57 ± 0.03[d]	17.22 ± 0.01[d]	130.41 ± 0.59[d]	1.80 ± 0.02[d]	3.62 ± 0.01[d]
F	53.89 ± 0.31[c]	18.67 ± 0.01[c]	138.21 ± 0.04[c]	1.88 ± 0.01[c]	3.77 ± 0.01[c]
G	56.88 ± 0.06[b]	19.75 ± 0.03[b]	153.72 ± 0.04[b]	2.16 ± 0.01[b]	3.86 ± 0.01[b]
H	58.35 ± 0.02[a]	20.26 ± 0.02[a]	161.28 ± 0.08[a]	2.32 ± 0.01[a]	4.21 ± 0.01[a]

Values are means of duplicate determinations ± standard deviation.
Mean values along the same column with different superscripts are significantly different ($p<0.05$)
A = Biscuit from 100% Wheat flour
B = Biscuit from 90% Wheat flour, 5% cocoyam flour and 5% groundnut flour
C = Biscuit from 80% Wheat flour, 10% cocoyam flour and 10% groundnut flour
D = Biscuit from 70% Wheat flour, 15% cocoyam flour and 15% groundnut flour
E = Biscuit from 60% Wheat flour, 20% cocoyam flour and 20% groundnut flour
F = Biscuit from 50% Wheat flour, 25% cocoyam flour and 25% groundnut flour
G = Biscuit from 40% Wheat flour, 30% cocoyam flour and 30% groundnut flour
H = Biscuit from 30% Wheat flour, 35% cocoyam flour and 35% groundnut flour

Potassium content of biscuit samples varied between 94.88 and 161.28 mg/100 g.
This showed an increase of 10.63 to 69.98% for biscuits fortified with cocoyam and defatted groundnut flours. It was observed that the inclusion of cocoyam and defatted groundnut significantly increased ($p< 0.05$) the potassium content of the biscuits. Similar observation was reported for enriched cookies from whole wheat and full fat soya by Ndife *et al*. (2014).
The zinc content of the biscuit samples oscillated between 1.03 and 2.32 mg/100 g. This depicted an increase of 19.42 to125.24% for biscuits fortified with cocoyam and defatted groundnut flours. It was observed that the addition of cocoyam and defatted groundnut significantly increased ($p< 0.05$) the zinc content of the biscuits. The same trend was reported for biscuits produced from wheat flour incorporated with rice bran (Younas *et al.*, 2011).
Iron content ranged between 3.32 and 4.21 mg/100 g. The iron content of all the fortified biscuit samples were significantly ($p<0.05$) higher than the control. Younas *et al*. (2011) observed similar increase in iron content for wheat biscuits fortified with rice flour.

Amino Acid Composition of Wheat-Cocoyam-Groundnut Biscuits

The amino acid composition in g/100 g protein of biscuits produced from wheat, cocoyam and defatted groundnut flour is presented in Table 5. Generally, the total amino acid of the biscuit samples ranged between 64.64 and 90.47 g/100 g protein of the biscuit samples. The total amino acid content of all the fortified biscuit samples were higher than that of the 100% wheat biscuit samples. The increase in the amino acid composition of the biscuit shows the higher protein content and quality of the biscuits produced from the composite flour. The results of the amino acid composition are generally in agreement with the observations of Okoye, (2016)
It was observed that the values of the total non-essential amino acids were higher than that of the total essential amino acids of all the biscuit samples. This observation was similar to the report of Ibrahim (2009) for tilapia fish enriched biscuit samples. The values of the total non-essential amino acids for the wheat-cocoyam-groundnut biscuits ranged between 38.97 and 54.84 g/100 g protein. The non-essential amino acids are those the body can synthesize and therefore non-essential in the diet.

Table 5. Amino Acid Composition (g/100 g protein) of Wheat-Cocoyam-Groundnut biscuit

Amino Acid	A	B	C	D	E	F	G	H
Isoleucine	3.21	3.41	3.6	3.73	3.86	3.99	4.19	4.83
Leucine	7.03	8.00	8.58	9.57	9.75	9.84	10.21	10.59
Lysine	2.97	3.02	3.13	3.21	3.24	3.29	3.42	3.67
Methionine	1.55	1.68	1.75	1.76	1.79	1.82	1.90	1.92
Phenylalanine	3.9	4.08	4.29	4.43	4.61	4.79	4.79	4.97
Valine	3.39	3.6	3.92	3.98	4.12	4.36	4.38	4.59
Threonine	2.83	3.01	3.16	3.39	3.61	3.69	3.72	3.83
Tryptophan	0.79	0.78	0.87	0.89	1.05	1.16	1.18	1.23
Total Essential	25.67	27.58	29.3	30.96	32.03	32.94	33.79	35.63
Non-Essential								
Glycine	2.99	3.18	3.56	3.73	3.74	3.82	3.90	4.01
Alanine	3.66	3.72	3.87	4.25	4.48	4.89	5.31	5.61
Serine	2.92	3.08	3.30	3.40	3.84	3.89	4.00	4.05
Proline	3.45	3.76	4.06	4.47	4.87	4.97	5.28	5.34
Aspartic acid	5.13	5.71	5.89	6.2	6.26	6.95	7.01	7.32
Glutamic acid	12.41	12.87	13.55	13.7	14.61	15.14	15.59	16.21
Histidine	1.53	1.76	1.69	1.82	1.92	2.11	2.20	2.38
Arginine	2.92	2.92	3.18	3.27	3.44	3.61	3.70	3.87
Tyrosine	2.75	3.10	3.19	3.44	3.79	3.96	3.96	4.13
Cysteine	1.21	1.27	1.33	1.45	1.57	1.70	1.82	1.92
Total Non-Essential	38.97	41.37	43.62	45.73	48.52	51.04	52.77	54.84
Total Amino acid	64.64	68.95	72.92	76.69	80.55	83.98	86.56	90.47

A = Biscuit from 100% Wheat flour
B = Biscuit from 90% Wheat flour, 5% cocoyam flour and 5% groundnut flour
C = Biscuit from 80% Wheat flour, 10% cocoyam flour and 10% groundnut flour
D = Biscuit from 70% Wheat flour, 15% cocoyam flour and 15% groundnut flour
E = Biscuit from 60% Wheat flour, 20% cocoyam flour and 20% groundnut flour
F = Biscuit from 50% Wheat flour, 25% cocoyam flour and 25% groundnut flour
G = Biscuit from 40% Wheat flour, 30% cocoyam flour and 30% groundnut flour
H = Biscuit from 30% Wheat flour, 35% cocoyam flour and 35% groundnut flour

The values of isoleucine, leucine, lysine, methionine, phenylalanine, valine, threonine and tryptophan of the wheat-cocoyam-groundnut biscuits were higher than that of the 100% wheat biscuit. The results also show that lysine and the sulphur containing amino acids (methionine, cysteine) and trytophan, which are known to be limiting in cereals and legumes, respectively are significantly improved in the blends. This shows that the complementary effect of cereal / legume mixture improves both the protein quality and the levels of the limiting amino acids. The same trend was observed by Okoye, (2016) who prepared biscuits from the blend of wheat, soybean and bambara groundnut flour. The essential amino acids were reported to increase with fortification of biscuits with germ flour by Youssef (2015). The essential amino acids are important from nutritional point of view since the body cannot synthesize them and should therefore be supplemented in the diet. The values of glycine, alanine, serine, proline, aspartate, glutamate, histidine, arginine, tyrosine and cysteine of the biscuit samples increased with addition of cocoyam and defatted groundnut flours. The results showed that the amino acid composition increased with incorporation of cocoyam and defatted groundnut flours to the wheat flour for the production of biscuits. This showed a direct relation with the crude protein contents of the biscuit samples since amino acids are building blocks of protein. The observation reported in this work is similar to the trend reported for amino acid composition reported for biscuit enriched with 0 to 5% tilapia fish concentrate by Ibrahim (2009).

4. CONCLUSIONS

The enriched biscuits had better nutritional properties. Thus, the enrichment of biscuits with cocoyam and groundnut could go a long way in increasing gross domestic product of the nations of the world while boosting nutritional profiles. Cocoyam and groundnut addition are valid value additions for biscuit production.

5. REFERENCES

[1]. Ajibola F.C, Oyerinde O.V. and Adeniyan S. O. Physicochemical and antioxidant properties of whole wheat biscuits incorporated with Moringa oleifera leaves and cocoa powder. Journal of Scientific Research and Report, 2015, 7(3)195 – 206.

[2]. AOAC. Official methods of Analysis (17th edn.) Association of Analytical Chemist, Washington D. C., USA, 2000.

[3]. AOAC. Official methods of Analysis (23rdedn.) Association of Analytical Chemist, Washington D. C., USA, 2006.

[4]. Bolarinwa, I. F., James A. A., Abioye, A. and Olanike, Z. Production and quality evaluation of biscuits produced from malted sorghum-soy flour blends. Journal of Advances in Food Science and Technology, 2016, 3: 107-113.

[5]. Benitez, L. V. Amino Acid and fatty acid profiles in aquaculture nutrition studies. S.S. De Silva (ed.) Fish Nutrition Research in Asia. Proceedings of the Third Asian Fish Nutrition Network Meeting. Asian Fish Society Special Publication, 1989, 4: 23-35.

[6]. Ceserani, V. and Kinton, R. (2008). Practical Cookery(10th ed.) John Wiley and Sons New York.

[7]. Ejoh, S. I., Obatolu, V. A., Olanipekun, O. T. and Farinde, E. O. (2013). Extending the use of an underutilized tuber: Physicochemical and pasting properties of cocoyam (Xanthosoma sagittifolium) flour and its suitability for making biscuits. *African Journal of Food Science*, 7(9): 264-270.

[8]. Ibrahim, S. M. (2009). Evaluation of production and quality of salt biscuits supplemented with fish protein concentrate. World Journal of dairy and Food Sciences, 4(1):28-31

[9]. Igbabul, B. D., Amove, J., and Twadue, L. Effect of fermentation on the proximate composition, antinutritional factors and functional properties of cocoyam (*Colocasia esculenta*) flour. African Journal Food Science Technology, 2015, 5(3): 67-74.

[10]. Kaushal, P., Kumar, V., Sharma, H. K. (2012). Comparative study of physico-chemical, functional, anti-nutritional and pasting properties of taro (*Colocasia esculenta*), rice (*Oryza sativa*), pegion pea (*Cajanus cajan*) flour and their blends. Food Science Technology,2012, 48:59–68.

[11]. Mgbemere, V. N., Akpapunam M. A. and Igene, J. Effect of groundnut flour substitution on yield, quality and storage stability of Kilishi – A Nigerian Indigenous dried meat product. African Journal Food Agriculture Nutrition Development, 2011, 11:4718- 4738.

[12]. Ndife J, Kida F and Fagbemi S. Production and quality assessment of enriched cookies from whole wheat and full fat soya. European Journal of Food Science and Technology, 2014, 2(1): 19 – 28.

[13]. Odunlade, T. V., Taiwo, K. A. and Adeniran, H. A. (2016). Functional and antioxidative properties of sorghum *ogi* flour enriched with cocoa. Annals. Food Science and Technology,2016, 17 (2): 497-506.

[14]. Ohimain E. I. The Prospects and Challenges of Cassava Inclusion in Wheat Bread Policy in Nigeria. International Journal of Science, Technology and Society. 2014, 2(1), 6-17

[15]. Ojokoh, A. O., Daramola, M. O. and Ochukwa, A. G. Studies on the Microbiological, Proximate Composition, and Anti-nutritional Content of Fermented Groundnut and Plantain Blends. The Pacific Journal of Science and Technology, 2014, 15:251-258.

[16]. Okoye, J. I. Amino acid composition and protein quality of wheat flour biscuits fortified with soybean and bambara groundnut flours. *Gjesr Research Paper*, 2016, 3: 2349 – 2356.

[17]. Okpala, L.C. and Chinyelu, V. A. Physicochemical, nutritional and organoleptic evaluation of cookies from pigeon pea (*Cajanus cajain*) and cocoyam (*Xanthosoma* sp) flour blends. Africa Journal of Food Agriculture and Nutritional Development, 2011, 11(6):5431-5443.

[18]. Olanrewaju, S. Prospects for cassava flour incorporation in bread making in Nigeria FHI 360, Abuja, Nigeria, 2012.

[19]. Oluwamukomi, M. O., Oluwalana, I. B. and Akinbowale, O. F. Physicochemical and sensory properties of wheat cassava composite biscuit enriched with soy flour. African Journal of Food Science, 2011, 5 (2): 50 – 56.

[20]. Oyeyinka, S. A., Oyeyinka, A. T., Karim, O. R., Toyeeb, K. A.,Olatunde, S. J. and Arise, A. K. Biscuit making potentials of flours from wheat and plantain at different stages of ripeness. Croatian Journal of Food Science and Technology, 2014, 6(1): 36-42.

[21]. Purohit, C. and Rajyalakshme, P. Quality of products containing defatted groundnut cake flour.

Journal of Food Science and Technology, 2011, 48(1):26-35.

[22]. Taiwo, E. O., Adesanwo A. S., Dauda O. A., Arise A. K. and Sotunde A. J. Chemical compositionand sensory qualities of wheat-sorghum date cookies. Croatian Journal of Food Technology, Biotechnology and Nutrition 2017, 12 (1-2), 71-76

[23]. Tyagi, S. K., Manikantan, M. R. and Oberoi, H. S. Effect of mustard flour incorporation on nutritional, textural and organoleptic characteristics of biscuits. Journal of Food Engineering, 2007, 80(4): 1043-1050.

[24]. Ullah, F., Ahmad, S., Wahab, S., Zeb, A., Khan Khattak, M., Khan, S., and Kang, M. Quality Evaluation of Biscuits Supplemented with Alfalfa Seed Flour. Foods, 2016, 5(4): 68.

[25]. Younas, A., Bhatti, M., Ahmed, A. and Yousaf, A. Effect of rice bran supplementation on cookie baking. Pakistan Journal of Agricultural Sciences,2011, 48(2):129-184

[26]. Youssef, H.M.K.E.Assessment of Gross Chemical Composition, Mineral Composition, Vitamin Composition and Amino Acids Composition of Wheat Biscuits and Wheat Germ Fortified Biscuits. Food and Nutrition Sciences, 2015, 6: 845-853.