Original Research Article

Quality evaluation of composite bread produced from wheat and fermented cashew kernel flours

Abstract

The aim of the research was to produce bread from composite flours of fermented cashew kernel-wheat flour, to determine its physicochemical and sensory properties. The Hagberg falling number (FN) and rheological properties of wheat flour replaced with fermented cashew kernel four at 10, 20 30 and 40% were evaluated. The physical properties and proximate composition of loaves were determined. Also its sensory characteristics were evaluated. Results showed that the substitution of wheat flour with fermented cashew kernel flour negatively impacted the rheological properties and increased the falling number. Thereby, composite flours obtained from wheat flour substitution with fermented cashew kernel flour at 10 and 20 percent levels were retained for bread production. The weight, volume and specific volume of loaves varied from 208 to 229 g, 433 to 657 cm^3 and 1.80 to 3.20 cm^3/g respectively. The crude protein, fat, crude fibre, moisture and ash contents of the composite breads increased significantly ($P<0.05$) with increase in the proportion of fermented cashew kernel flour. The carbohydrate contents were observed to decrease significantly ($P<0.05$) from 38.08 to 56.18 % with increase in the percentage of the cashew kernel flour incorporation. Sensory evaluation of the bread samples showed that substitution level of 10% fermented cashew kernel flour produced bread that was acceptable to the consumers whereas at 20% were neither like nor dislike. It is therefore recommended that substitution level of not more than 20% cashew kernel flour be used for fermented cashew kernel/wheat composite bread production.

Keywords: fermented cashew kernel; Composite flour; Dough rheology, Bread, Quality

1. INTRODUCTION

In 2015, with 1 600 000 tons, Africa accounted for 49 % of world cashew production. However, Africa processes less than a quarter of its production **[1].** Côte d'Ivoire, the world's largest producer of cashew nuts, processes only about 5 to 7 percent of its production **[2].** This situation makes the income of producers unstable and dependent on the international market, which is narrow and volatile. To make the situation of high cashew production profitable, it would be necessary to transform cashew nut and consume products based on cashew kernels locally. This would contribute to improving food security in Africa and particularly in Côte d'Ivoire.

Cashew kernel flour using for the bakery and pastry products formulation offers a real potential for cashew kernels valorization because in most African countries, consumption has increased considerably in recent years **[3]**. This increased trend in bread consumption has been the result of a number of factors including growing population, urbanization and increased wealth in these countries **[4].** Cashew kernels flour using for the bakery and pastry products formulation reduce total dependence on imported wheat flour and save foreign exchange for countries of sub-Saharan Africa. Cashew kernels contain essential nutrients such as protein, fat, fibre and appreciable amounts of minerals **[5-6]**. It using in bread production enhance nutrients of the bread **[7].**

However, tanins, phytates and oxalates have been considered as antinutritional factors because they interact with vegetable food source constituents such as carbohydrates, proteins and minerals and make them unavailable **[8-9-10].** Fermentation was used to reduce these undesirable compounds, enhance phenolic compounds and nutritional qualities of cashew kernel flour **[11].** Fermentation also brings change in colour, flavor and texture of the food **[12].** This change enhance sensory properties of foods **[13]**

The aim of the research is therefore to produce bread from composite flours of wheat and fermented cashew kernels flour and to determine its physicochemical as well as the sensory properties of the bread.

2. Materials and Methods

2.1 Materials

The small Pieces of cashew kernels were purchased from a local supplier based in Yamoussoukro (Côte d'Ivoire). Food ingredients including wheat flour (Type 55), baker's yeast (*Saccharomyces cerevisiae*), salt, and bread improver were purchased from a supermarket in Yamoussoukro (Côte d'Ivoire).

2.2 Methods

2.2.1 Production of fermented cashew kernel flour

The cashew kernels were sorted to get rid of foreign bodies and unhealthy almonds. They were then dried in an oven for 6 hours at 60 °C. The sorted kernels were fermented using the modified method described by Ijarotimi et al. **[14].** Almonds (1 kg) are boiled at 100° C with distilled water for 30 minutes. They were wrapped in plantain leaves to be fermented for 72 hours. The fermented kernels were dried in a ventilated oven at 65 °C for 48 hours. The fermented kernels oil was then extracted according to the modified method proposed by Sze-Tao and Sathe **[15]**. The oil of the previously treated kernels was extracted twice with n-hexane at a ratio of 1:1 (w / w). The oilcakes were reduced to flour using a hammer mill (YIBU, type 30, China) containing a 150 µm mesh screen. The flour obtained is placed in polyethylene bags and stored at room temperature.

2.2.2 Preparation of Composite Flour

Four flour blends, each containing wheat flour (WF) and fermented cashew kernel flour (FC) were prepared by mixing flours in the proportions (w/w) of 90:10 (WF10FC), 80:20 (WF20FC), 70:30 (WF30FC) and 60:40 (WF40FC) respectively, using a blender, (PHILIPS, HR2145/90). The control sample was 100% wheat flour.

2.2.3 Bakery value

Hagberg falling number was determined according to International approved methods 56-81.03 **[16]**.

The alveograph (Chopin NG, France) was used to measure characteristics that provided insight in to the fermentation tolerance of the dough as may be exhibited during proofing stage of bread making with a built-in diaphragm pump to supply air for inflating the tested dough piece **[17]**. Characteristics of interest that were measured included the average resistance to expansion indicated by tenacity (P), extensibility indicated by length (L) of the alveogram curve, stability (P/L), energy input required for the mechanical deformation of the dough (W), inflation required for maximum development (G).

2.2.4 Baking Process

In the bread-making process, the ingredients (yeast, salt, water, and flour) were mixed at low speed and the mass was kneaded for 15 min at high speed in a spiral kneader

(MAHOT, France). Dough was separated into 250 g pieces and are left standing for 10 minutes**.** The pieces of dough were put in short baguette form and a second fermentation was carried for 1 hour during at 27 °C in a fermentation chamber. When the baguettes were ready-to-bake, incisions were made with a cutter. Baguettes were baked in an oven (BONGARD) at 235 °C for 30 min with steaming.

2.2.5 Determination of physical properties of bread samples

The volume was determined using the volumetric deplacement method in which the rapeseed displacement was modified by using soybean **[18]**. Specific volume (SV) was calculated as the ratio of volume to the weight.

2.2.6 Nutritional composition bread samples

The moisture content and fat content of the various breads samples were performed using **[19]**. The crude protein content was determined by estimating the nitrogen content using the Kjedahl method **[20]**. Ash and carbohydrates (by difference) were analyzed using the standard method of AOAC **[21].** Bread samples were analyzed for fiber content according to the method described in paper **[22].**

2.2.7 Sensory evaluation

A panel of sixty consumers was recruited from staff and students of Institute National Polytechnique, Félix Houphouët-Boigny (INPHB), Yamoussoukro, Côte d'Ivoire. Criteria for selection were that panelists were regular consumers of bread and were not allergic to any food. Panelists were instructed to evaluate color, taste, texture, aroma and general acceptability. A 9-point hedonic scale with 1 = dislike extremely, 5= neither like nor dislike and 9= like extremely was used. Samples were coded and presented in a random sequence to the panelists as described by Meilgaard et al **[23].**

2.2.8 Statistical analysis

All analyses were made in triplicates. Statistical analysis was carried out using Statistica 7.1 software. Newman-keuls multiple means comparison test was used to verify differences between the samples. Likelihood level $P < 0.05$, was set as the criterion of significance.

3. RESULTS AND DISCUSSION

3.1 Bakery value of composite blends with fermented cashew kernel flour.

Table 1 presents the Bakery value of wheat and composite flours. Hagberg Falling Number (FN) measures the liquefaction of the gelatinized starch by the α-amylase in the test sample. The FN increased with increased wheat flour replacement. This indicates a low amylase activity of composite flours (fermented cashew kernel / wheat) which could be explained by the low starch content and / or a low presence of α-amylase in fermented cashew kernel meal. The decrease in amylase activity leads to a minimum of liquefaction of the starch and has a very high water retention capacity. As a result, compared with wheat flour, composite flours would have a higher viscosity. The consequence of this high viscosity on composite breads is a small volume because a high viscosity opposes the emergence under the effect of gas (carbon dioxide) **[24].** According to **[25]** an optimal enzymatic activity which corresponds to a FN of between 200 and 300 seconds is essential for obtaining a bread of high volume, homogeneous and appreciable crumb. Moreover, according to known hyperbolic dependence of the FN on the α-amylases activity, values over 400 seconds signify such enzymatic activity is limiting to zero.

Rheological properties of composite flour

The alveograph is an important dough testing instrument use to evaluate the quality of wheat flours for bread making **[26].**

The tenacity (P) values ranged from 59 to 101 mm with the composite flour 30% and the 20% FC blend offering the least and highest resistance to expansion, respectively (Table 5). The flour is of standard quality for P between 60 and 80 mm, it is of very good quality for P situated between 80 and 100 mm **[27].** Taking into account this classification, the composite flours WF10FC and WF20FC could give pastes with acceptable tenacity in bakery.

The maximum inflation (G) ranged from 9.2 to 18.2 cm^3, decreased significantly as WF was replaced with FC. The WF had significantly higher values than other blends. The inflation (G) values are lower than those recommended by Roussel **[28]** who reports that a bread flour must have a maximum inflation (G) between 19 and 23 cm^3.

The length (L) indicated the extensibility of the dough. The L values ranged from **17** to 67 mm with the 30% FC blend WF having the least and highest extensibility, respectively. The extensibility of composite dough reduction could be explained by the descent in gluten content due to the substitution of WF for FC.

The stability P/L (configuration ratio) ranged from 1.1 to 3.45. The wheat flour and 30% FC had the highest and lowest values, respectively.

The energy (W) ranged from 95 × 10^{-4} J in the case of the 30% blend to 208 × 10^{-4} J in the case of WF. It decline with substitution levels and the WF and offered significantly better energy. According to **[29],** a flour can be oriented to bread making when its configuration ratio P/L is in the range of 0.8 to 2. The composite flours WF10FC and the limit WF20FC could be adapted to bread making because the ratio P/L are close to 2.

In addition according to Algerian standards **[30]**, composite flours WF10FC and WF20FC are classified as flour of good baking strength because they have their W between 130 and 180 × 10^{-4}joules.

The quantity and quality of gluten proteins are important factors in bakery. In this study, reduced gluten quantity, impacted negatively on the rheological properties of the dough. However, the composite flours WF10FC and WF20FC could be used to produce bread.

		Rheological properties				
Flour blends	**FN (s)**	**P (mm)**	**G (cm^3)**	**L (mm)**	**P/L**	**W (10^{-4} J)**
FC	ND	ND	ND	ND	ND	ND
WF10FC	315±3	67	16.1	49	1.37	178
WF20FC	333±2	101	15.5	40	2.5	132
WF30FC	351±4	59	9.2	17	3.45	95
WF40FC	364±2	ND	ND	ND	ND	ND
WF	298±3	73	18.2	67	1.1	208

Table 1: **Hagberg falling number and alveogram of wheat flour and its composite blends with fermented cashew kernel flour.**

ND: Not determineted
WF*: Wheat flour;*
WF10FC: ***90% wheat flour + 10% fermented cashew kernel flour;***
WF20FC: ***80%wheat flour + 20% fermented cashew kernel flour;***
WF30FC: ***70% wheat flour + 30% fermented cashew kernel flour***;
WF40FC: ***60%wheat flour + 40% fermented cashew kernel flour***.

3.2 Physical properties of bread samples

The weight, volume and specific volume **(Table 2)** of the loaves ranged from 208 to

229 g, 433 to 657 cm^3 and 1.80 to 3.20 cm^3/g respectively. The loaf volume and specific loaf volume was observed to diminish significantly (P<0.05) as the proportion of FC increased from 10% to 20%. This could be due to reduction of the quantity of gluten in the dough with addition of composite flour resulting to less retention of carbon dioxide gas and a dense texture **[31].** The gluten causes the dough to extend and trap the carbon dioxide produced by yeast during fermentation making the dough to be elastic and retain high volume. The weight of the loaves increased with increase in FC.

This may be as a result of higher water absorption observed in the FC based bread samples during the dough mixing process.

Furthermore, the reduction of trapped air causes the thickening of the dough and this gives heavy loaves **[32]**.

Table 2 : Physical properties of bread samples

	Physical properties		
Samples	**Weight (g)**	**Volume (cm^3)**	**Specific volume (cm^3/g)**
WF10FC	229.23±4.54^{c}	433.43±3.67^{c}	1.80±0.09^{c}
WF20FC	221.85±2.24^{b}	544.31±5.57^{b}	2.48±0.05^{b}
WF	208.02±5.46^{a}	657.02±6.26^{a}	3.20±0.03^{a}

Values in the same column with different superscript are significantly different at P<0.05

Values are means ± standard deviation of duplicate determinations

WF***: Wheat flour;***

WF10FC***: 90% wheat flour + 10% fermented cashew kernel flour;***

WF20FC***: 80%wheat flour + 20% fermented cashew kernel flour.***

3.3 Proximate composition of bread samples

The proximate composition of the bread samples is shown in Table 3. The moisture, ash, protein, fat and fibre contents of the bread samples increased significantly (P<0.05) with elevated substitution of WF by FC. The moisture content varied from 28.48 to 38.21%, the ash varied from 0.58 to 0.81% while the protein, fat and fibre content ranged from 13.83 to 19.57 %, 1.03 to 3.37 % and 0.54 to 0.83 % respectively. The raise of proteins, fat, ash and fibre contents could be attributed to the FC which is rich in protein, fat, minerals and fibre

[33]. These results are consistence with article **[34]** in incorporation fermented chickpea flour to bread. The increased protein content is an indication that substitution of WF with FC greatly improved the protein and nutritional quality of the bread. Thus the enriched bread would be used to solve malnutrition problems. Cashew kernel is reported to contain all the essential amino acids **[35].** High fibre is reported by Schneeman **[36]** to enhance the gastrointestinal tract health. It helps normal bowel movements thereby reducing constipation problems.

The inclusion of FC to the formulation decreased the carbohydrate contents with regard to the control sample. The low carbohydrate content of composite breads would be importance in reducing the risk of diabetes linked to the low glycemic index of this type of food **[37]**.

Table 3: Proximate composition of bread samples

Parameters	WF20FC	WF10FC	WF
Moisture (%)	38.21 ± 0.51^{b}	34.25 ± 0.86^{a}	28.48 ± 0.72^{c}
Ash (%)	0.81 ± 0.02^{b}	0.66 ± 0.01^{a}	0.58 ± 0.06^{c}
Protéin (%)	19.57 ± 0.58^{b}	15.45 ± 0.55^{a}	13.83 ± 0.76^{c}
Fat (%)	3.37 ± 0.3^{a}	2.17 ± 0.15^{a}	1.03 ± 0.47^{b}
Carbohydrate (%)	38.08 ± 0.49^{b}	47.45 ± 1.44^{a}	56.18 ± 1.23^{c}
Crude fibre (%)	0.83 ± 0.04^{b}	0.76 ± 0.01^{a}	0.54 ± 0.02^{c}
Energy (kcal/100g)	260.83 ± 3.16^{a}	255.74 ± 3.89^{a}	289.33 ± 2.03^{b}

Values in the same row with different superscript are significantly different at $P<0.05$

Values are means ± standard deviation of duplicate determinations

WF*: **Wheat flour;***

WF10FC ***10: 90% wheat flour + 10% fermented cashew kernel flour;***

WF20FC***: 80%wheat flour + 20% fermented cashew kernel flour.***

3.4 Sensory characteristics of bread samples

The sensory evaluation scores are presented in Table 4. According to the performed statistical analysis, the substitution of WF significantly affected negatively crumb colour, bread texture, taste, aroma and overall acceptance. The formulation of bread substituted with

20 % FC exhibited the lowest colour, texture, taste, aroma and overall acceptance scores among the three variant breads. This result may be attributed to the compactness and hardness of the bread crumb, which resulted from the low specific volume obtained from WF20FC, as mentioned earlier (Table 2). This result may be also attributed to the brown colour of the crumb as well as to the taste and aroma developed by cashew kernel fermentation. The appearance, texture and colour of the bread is an important sensory characteristic for consumers **[38]**. In literature, there is agreement that sensory attributes in terms of texture and overall acceptance decreased when addition of chickpea flour in bread **[39]**. Panelists prefer bread with the WF for the crumb colour and bread texture, taste and aroma. However, Panelists judged the WF10FC was acceptable as it received score greater than 5 of overall acceptance. The result obtained from this present study is in good agreement with that reported by Yaou et al **[40].**

According to these authors, the substitution of wheat flour with fermented cassava flour at a rate between 0 and 20% makes it possible to have bread accepted by the panelists

Table 4: Sensory properties of bread samples

Bread samples	**Parameters**					
	Colour (Crust)	**Colour (crumb)**	**Texture**	**Taste**	**Aroma**	**Overall acceptance**
WF20FC	6.40±0.50^{b}	4.63±0.54^{c}	6.2±0.69^{c}	5.65±0.48^{c}	5.25±0.44^{c}	5.45±0.51^{c}
WF10FC	8.38±0.60^{a}	5.72±0.43^{b}	7.27±0.46^{b}	6.66±0.48^{b}	6.27±0.46^{b}	7.16±0.7^{b}
WF	8.04±0.66^{a}	7.5±0.38^{a}	8.09±0,62^{a}	7.38±0.49^{a}	7.38±0.58^{a}	8.66±0.57^{a}

Values in the same row with different superscript are significantly different at $P<0.05$

Values are means ± standard deviation of duplicate determinations

WF***: Wheat flour;***

WF10FC***: 90% wheat flour + 10% fermented cashew kernel flour;***

WF20FC***: 80%wheat flour + 20% fermented cashew kernel flour.***

CONCLUSION

This study has shown that bread of acceptable quality can be produced from composite flours at 10 % level of flour substitution fermented cashew kernel. The bread samples produced have increased nutrients of fibre, protein and ash contents which are all desirable for good health and provide nutritious bread to combat malnutrition problems and enhanced food security. Fermented cashew kernel flour using to produce bread would improve the processing and consumption of cashew kernels locally and consequently, stabilize the income of cashew nut producer. In addition, further research is needed to optimize the processing and formulation factors in FC–wheat bread manufacture to maximize the level of FC incorporation while maintaining improved quality properties and high consumer acceptability, to give a product with maximum potential nutritional.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. ACA. African cashew alliance. Rapport Annuel. 20p; 2015**.**

2. PSAC**.** Projet d’appui au Secteur Agricole en Côte d’Ivoire. Plan de gestion des pestes et pesticides (PGPP) du projet d'appui à la compétitivité de la chaîne de valeur de l'anacarde en Côte d'Ivoire. 2016**: 1-7.**

3. Rinaldi M, Paciulli M, Caligiani A, Sgarbi E, Cirlini M, Dall’Asta C, Chiavaro E. Durum and soft wheat flours in sourdough and straight-dough bread-making. *Journal of Food Science and Technology*. 2015; 52(10):6254–6265.

4. Ogunjobi MAK, Ogunwolu SO. Physicochemical and sensory properties of cassava flour biscuits supplemented with cashew apple powder. *Journal of Food Technology*. 2010; 8(1): 24-29.

5. Freitas JB, Naves MMV. Chemical composition of nuts and edible seeds and their relation to nutrition and health. Revista de Nutrição Campinas. 2010; 23(2): 269-279.

6. Akinhanmi TF, Atasie VN**.** Chemical Composition and Physicochemical Properties Of Cashew nut (*Anacardium occidentale*) Oil and Cashew nut Shell Liquid J. Agric. Food Environ. Sci. 2008; 2 (1)**:**1-10.

7. Badjé DS, Soro D, Yeo MA, Koffi KE. Physico-chemical, functional and sensory properties of composite bread prepared from wheat and defatted cashew (*Anacardium occidentale* L.) Kernel Flour. International Journal of Environmental & Agriculture Research. 2018; 4(4): 88-98.

8. Abd El Rahaman SM., El Maki HB, Idris WH., Hassan AB, Babiker, EE, El Tinay AH. Antinutritional factors content and hydrochloric acid extractability of minerals in pearl millet cultivars as affected by germination. International Journal of Food Sciences and Nutrition . 2007; 58(1): 6–17.

9. Idris WH, Abd El Rahaman SM, El Maki HB, Babiker EE, El Tinay AH. Effect of malt pretreatment on phytate and tannin level of two sorghum (Sorghum bicolor) cultivars. International Journal of Food Science & Technology. 2006; 41(10): 1229–1233.

10. Sefa-Dedeh S, Agyir-Sackey K E. Chemical composition and the effect of processing on oxalate content of cocoyam *Xanthosoma sagittifolium* and *Colocasia esculenta cormels*. Food Chemistry. 2004; 85(4): 479–487.

11. Touzou BJJ, Soro D, Soro S, and Koffi KE. Effects of fermentation on the physico-chemical and functional characteristics of composite flours made from cashew Almond (*Anacardium occidentale*) and wheat (*Triticum aestivum*). International Journal of Innovation and Scientific. 2018; 37(1): 58-69.

12. Oyewole OB. Lactic fermented foods in Africa and their benefits. Food Control. 1997; 8(5): 289-297.

13. Inyang CU, Zakari UM. Effect of germination and fermentation of peart millet on proximate, chemical and sensory properties of instant “fura”- a Nigerian cereal food. Pakistan Journal of Nutrition. 2008; 7: 9-12.

14. Ijarotimi OS, Oluwalana IB, Ogunedojutimi MO. Nutrient composition, functional, sensory and microbial status of popcorn based (*zea may everta*) complementary foods enriched with cashew nut (*anacardium occidentale l.*) flour. African Journal of Food Science. 2012; 12(5): 6424-6446.

15. Sze-Tao KWC, Sathe SK. Functional properties and in-vitro digestibility of Almond (*Prunusdulcis L*) protein isolate, *Food chemistry.* 2004; 69 (2): 153- 160.

16. AACC International, “Determination of falling number,” in *Approved Methods of Analysis*, Method 56-81.03, AACC International, St. Paul, Minn, USA, 11th edition, 2010.

17. AACC. American Association of Cereal Chemists International. Approved Methods of Analysis, 11th Ed. Method 54-30.02. Physical Dough Tests: Alveograph Method for Soft and Hard Wheat Flour. AACC International, St. Paul, MN. http://dx.doi.org/10.1094/ AACCIntMethod. 2010.

18. Shittu AT, Rashidat AA, Evelyn OA. Functional effects of xanthan gum on composite cassava-wheat dough and bread. *Food Hydrocolloids*. 2009**;** 23(8): 2254–2260.

19. AOAC. Official methods of analysis of the Association of Official Analytical Chemists. 15th Edition, Washington, DC; 1990.

20. AOAC. Official methods of analysis of the Association of Official Analytical Chemists. 16 th Edition, Arlington, VA, USA; 1995.

21. AOAC. Official method of analysis of the Association of Official Analytical Chemist. 5th Edition. AOAC Press, Arlington, Virginia, USA; 2005.

22. AOAC. Official methods of Analysis .Association of official analytical chemist.17th Edition, Washington, DC; 2000.

23. Meilgaard M, Civille GV, Carr BT. Sensory Evaluation Techniques. CRC Press, Boca Raton; 1999.

24. Launay B, Buré J. Study of some rheological properties of flour dough and influence of kneading time on these properties. Dechema Monographien. 1974, 77:137-152.

25. Godon B. and Loisel W. (1997). Practical guide for analysis in the cereals industries. Tec and doc. Lavoisier. Paris. 813 p.

26. Janssen, A. M., T. van Vliet, and J. M. Vereijken. 1996. Fundamental and empirical rheological behaviour of wheat flour doughs and comparison with bread making performance. J. Cereal Sci. 23:43–54.

27. Bordes J., Branlard F. X. Oury F. X. Charmet G. et Balfourier F. (2008). Agronomic characteristic, grain quality and flour rheology of 372 bread wheat in worldwide core collection. Journal of cereal science, 4: 569-579.

28. Roussel PH. Caractéristique boulangères des blés de la nouvelle campagne. Industrie des céréales. 1980; 6:33-43.

29. Liu DC, Hu XH, Zhang WN, Wang Y, Liu YF. Research on preparation and functional properties of peanut flour and peanut protein concentrate. China oils and fats. 1996; 21 (3): 5-7.

30. J.O.R.A. (1991)**.** Décret executif N° 91/572 du 31 décembre relatif à la farine de panification au pain.

31. Rao HP, Hemamalini R. Effect of incorporating wheat bran on rheological characteristics and bread makingquality of flour. Journal of Food Science and Technology. 1991; 28:92-97.

32. Horsfall D. Mepba1, Lucy Eboh, Nwaojigwa SU. Chemical Composition, Functional And Baking Properties of Wheat-Plantain Composite Flours. AJFAND. 2007; 7 (1): 55-64.

33. Kone S, Soro D, Soro S, koffi K E**.** Effects of Fermentation of Cashew Kernel on the Nutrient Value of Cassava Semolina Flour (Attieke)**.** International Journal of Environmental & Agriculture Research. 2017**;** 3(12): 57-64.

34. Xiao Y, Huang L, Chen Y, Zhang S, Rui X, Dong M. Comparative study of the effects of fermented and non-fermented chickpea flour addition on quality and antioxidant properties of wheat bread. CyTA-Journal of Food. 2016; 14:(4) 621-631.

35. Ihekoronye, A. I. and Ngoddy, P.O. Integrated Food Science and Technology for the Tropics. Macmillan publishers, New York. 1985, Pp 296-301.

36. Schneeman BO. Gastrointestinal physiology and functions. British Journal of Nutrition. 2002; 88 (2); 159-163.

37. Ugwuona FU, Ogara JI, Dawogbenja M**.** Chemical and sensory quality of cakes formulated with wheat, soybean and cassava flours. Indian journal of sciences. 2012**;** 1 (2):1-6.

38. Ho LH, Aziz NAA, Azahari B. Physico-chemical characteristics and sensory evaluation of wheat bread partially substituted with banana (*Musa acuminata* X balbisiana cv. Awak) pseudo-stem flour. . Food Chemistry. 2013; 139(1–4): 532–539.

39. Man S, Păucean A, Muste,S, Pop A. Effect of the chickpea (*Cicer arietinum* L.) flour addition on physicochemical properties of wheat bread. Bulletin of University of Agricultural

Sciences and Veterinary Medicine Cluj-Napoca. Food Science and Technology. 2015; 72(1): 41–49.

40. Yaou BI, Bessou F, Tchekessi C, Metohoue R, Toukourou F, Souza AC. Substitution de la farine de blé par la farine fermentée de manioc (*lafu)*, dans la préparation du pain de boulangerie. Journal de la Recherche Scientifique de l'Université de Lomé. 2012; 14(1) : 1-9.