Effect of Fermented and Unfermented Sesame Seed Meals on Nutrient Composition and Sensory Properties of Muffin Cake

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ABSTRACT

Background: *Sesame is produced abundantly in Nigeria but is mostly exported as cash crop. The seed is rich in protein, fibre, oil and minerals, and could be incorporated into widely consumed goods like cake to benefit Nigerians. Cake is widely consumed by most Nigerians.*

Objective: *The study aimed at using fermented (FSM) and unfermented (USM) sesame seed meals to improve quality of muffin cakes.*

Methods: *Sesame seeds were divided into two equal portions of 1.5kg each. One portion (USM) was soaked in excess cold water (26±2OC) for 3h and the fermented (FSM) in excess cold water (26±2OC) for 18h. Both were de-hulled, washed, sun-dried for 3 days, oven-dried at 50OC for 72h and then milled into powder. The USM and FSM flours were analysed for nutrient composition. Cakes were prepared with 0 (control), 25 and 50 % levels of USM or FSM and then analysed for quality characteristics.*

Results: *Fermentation (18 h) improved flour protein (from 13.56 to 14.20%, ash (from 5.10 to 5.5%), calcium and magnesium but decreased carbohydrate, phosphorus and zinc contents. USM and FSM improved cake quality. At 50% addition, USM improved protein content from 18.1 to 18.9% and calcium 116.3 to 180.3 mg/100g while FSM improved protein to 21.5% and calcium to 200.1 mg/100g. Iron, phosphorus and zinc increased similarly while magnesium decreased. Cakes with USM and FSM were adequately accepted*

Conclusion: *Both fermented and unfermented sesame seed meals improved quality of muffin cakes, and should be incorporated into cakes to benefit consumers nutritionally.*

Key wards: Sesame, fermentation, cake quality.

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INTRODUCTION

Cakes constitute major components of human snacks in most part of the world. It is a sweet pastry product made from wheat flour, shortening (hydrogenated fat), sugar, egg and is usually made light by the addition of baking powder [1]. Wheat flour constitutes the basic ingredient for cake production because of its gluten, which are not present in the flour of other cereals [2]. Gluten forms elastic dough during baking and gives high organoleptic quality to the cake [3, 4, 5].

Wheat production in Nigeria is low due to poor climatic conditions. Also wheat flour is low in protein, particularly the essential amino acids [2]. Complementing wheat flour with legume flours in pastry products in order to reduce production cost and increase protein content have long been advocated by many researchers [6]. Flours of common legumes like cowpea, flaxseed, bambara nut, African breadfruit, pigeon pea, jack bean, soybean and sesame seeds are well known to be rich sources of nearly all the essential amino acids needed by man, and these flours scan be used in supplementation with wheat flour in bakery foods [7, 8, 9, 10].

Nigeria, especially the North Central States, including Nasarawa State, is potentially endowed with sesame crops which is cheap and used in soup making in most homes. This work is designed to economically complement wheat flour with unfermented and fermented sesame seed flours for the production of muffin cakes. Sesame seed contains about 45-50% oils and 19-25% protein [11]. The high oil, calcium, iron and protein particularly methionine contents of sesame makes it very important for pregnant and lactating women [12]. Sesame serves as a good supplement in food and feed prepared from cereal and tuber crops. It is a good source of high quality oil that is resistant to oxidative rancidity. Sesame oil serve as an anti-oxidant in the manufacturing of margarine and salad cream [13, 14]. The oil is used as a pain reducing agent and in the treatment of dysentery, diarrhoea, ulcers and as an ointment [15, 16].

MATERIALS AND METHODS

Materials

Sesame seed was purchased from a local farmer in Doma market, Doma while wheat flour (Triticum indicum), sugar, hydrogenated fat, egg and baking powder were purchased from commercial stockers in Lafia main market, all in Nasarawa state, Nigeria. All the laboratory reagents used in this work were of analytical quality.

Methods

Processing of sesame seed meal

Sesame seed (3 kg) was cleaned and washed thoroughly to remove dirt and stones and then divided into two subsamples (A and B) of 11/2 kg each. Subsample A was soaked in excess water at room temperature for 3 h, washed and allowed to sun-dry for 3 days. The second subsample B was soaked in excess clean water for 3h, washed and then soaked in fresh excess clean water for 18h for fermentation. It was washed and then sun dried for 3 days. Both the unfermented and fermented subsamples were further dried in a hot air-oven at 50OC for 72h and then milled into flour. Both samples were used for the baking study.

Flour Blend Preparation

Wheat flour (WF) was blended with unfermented (USM) or fermented (FSM) sesame seed meal (WF: USM or WF: FSM) in the ratio of 75: 25 and 50: 50; 100% wheat flour was used as a control.

Preparation of cake samples

Cake samples were baked from batters formed by homogenously mixing the wheat flour (WF) (700 g) or wheat-sesame meal blends (700 g), butter (50 g), egg (400 g), sugar (250 g) and baking powder (20 g) in a clean bowl. Firstly, butter was added to the mixture of the dry ingredients and was further mixed, after which the egg was added to the mixture to produce stiff batters. The batters were scaled to 100 g sizes and moulded into heart- shaped samples. The 100 g samples were placed in 150 mL frustum aluminium pans that were greased with vegetable oil. There were covered with muslin cloth and allowed to ferment for 30 min at room temperature (28±2OC).After fermentation, the batters were baked in an electric oven maintained at 150OCfor 50 min. Cakes were cooled for about 5h, and then assessed for chemical composition, physical and sensory properties.

Nutrient analysis

The wheat, sesame meal and cake flours samples were analysed for moisture, crude protein, crude fat, crude fibre and ash contents according to the method of Association of Official Analytical Chemists [17]. Moisture was measured as the loss in weight after heating 2g of samples in a vacuum oven at 105OC for 4h. Crude protein was determined by Micro-Kjeldhal (N x 6.25) method, crude fat was determined using Soxhlet extraction method and ash content was determined by incineration of the fat-free subsample in a muffle furnace at 600 OC. Part of the fat-free subsample was digested alternatively with 1.25% H_2SO_4 and NaOH to determine the crude fibre. The minerals content, namely, calcium, iron, magnesium and zinc were determined after wet digestion, using atomic spectrophotometer (ASS), while phosphorus was determined using the Vanadomolybdate method [17].

Sensory Evaluation of Cakes

Sensory evaluation (colour, flavour, texture and mouth-feel, and over-all acceptability) of the muffin cakes was conducted in an exploratory test to determine the level of acceptability of sesame seed flour in the cakes. Cakes with 100% wheat flour served as a positive control. Hedonic test was applied using nine categories of appreciation of the cakes. The appreciations were balanced and equidistant with the following evaluations: 1= extremely disliked, 2= very disliked, 3= moderately disliked, 4= slightly disliked, 5= neither disliked nor liked, 6= slightly liked, 7= moderately liked, 8= very liked, 9= extremely liked [18, 19]. The test was conducted by 20-member untrained panellists in a sensory evaluation room illuminated with white fluorescence light in individual partitioned booths. Panellists attended three sessions and at each session, samples (five slices of cakes of uniform sizes) were served to panellists in white saucers randomly coded with three-digits-and one-letter numbers at room temperature (28±2OC); with water to rinse mouth between evaluations. Panellists were asked to record their scores on a score sheets provided.

Statistical Analysis

Analysis of Variance (ANOVA) was used to compare differences among cake samples. Fisher's least significant difference (LSD) was used to separate means where significant difference exists at $p < 0.05$.

RESULTS

Nutrient Composition of Wheat, Unfermented and Fermented Sesame Seed Flours

The proximate composition of wheat, fermented and unfermented sesame seed meals are presented in Table 1. The results showed significant ($p<0.05$) variations in the proximate contents of the wheat flour (WF), unfermented (USM) and fermented (FSM) sesame seed meals. The moisture contents ranged from 32.30% (USM) to 43% (FSM). The crude protein was highest in FSM (14.20%), followed by USM (13.56%) and lastly the WF (11.22%). The fat content of the samples maintained the same trend with the FSM having the highest value (6.20%), followed by USM (6.0%), and WF had the least value (5.70%). Ash content was higher in FSM (5.50%), high in USM (5.10%), while the least was in WF (0.7%). The USM had 0.9% fibre content while the FSM was 0.7%. Carbohydrate content was highest in WF (46.3%), higher in USM (42.14%) and high in FSM (30.40%), respectively.

There were significant ($p<0.05$) variations in the mineral contents of the flours (Table 1). The mineral contents ranged for Ca and Mg from 108.3 mg/100g and 24.9 mg/100g in wheat flour to 248.1 mg/100g and 42.1 mg/100 g in fermented sesame seed meal. Also, P ranged from 7.9 mg/100 g in wheat flour to 37.3 mg/100 g in unfermented sesame seed meal, Fe and Zn contents ranged from 24.0 and 0.64 mg/100 g in fermented sesame meal to 34.8 mg/100g and 1.9 mg/100 g, respectively.

Proximate Composition of Muffin Cakes

The proximate composition of muffin cakes made from wheat flour, unfermented and fermented (18 h) sesame seed meal is shown in Table 2. Cakes with 25% unfermented sesame seed meal (WSU1) and 25% fermented sesame meal (WSF1) inclusion had 49.74 % and 38.97% carbohydrate, 21.3% and 31.28% moisture, 18.60% and 18.68% protein, 6.5% and 6.72% fats, 2.60% and 3.05% ash and 1.20% and 1.03% fibre, while cakes with 50% unfermented sesame meal (WSU2) and 50% fermented sesame meal (WSF2) had 34.67% and 34.93%carbohydrate, 35.60% and 31.32% moisture, 18.88% and 21.50% protein, 6.80% and 6.85% fats, 2.90% and 4.10% ash and 1.10% and 1.30% fibre contents, respectively. The cake with 100% wheat flour (the control, WF) had 43.48% carbohydrate, 30.40% moisture, 18.10% protein and 6.22% fats, 1.10% ash and 0.7% fibre respectively.

Table1: Nutrient composition of wheat, unfermented and fermented sesame seed flour

Nutrients	Wheat Flour	Unfermented Sesame Seed flour	Fermented Sesame Seed flour
Carbohydrates (%)	46.30 ±0.19	42.14 ±0.18	30.40 ±0.38
Moisture (%)	35.94 ±0.22	32.30 ±0.19	43.0 ±0.16
Protein (%)	11.22 ±0.03	13. 56 ±0.04	14.20 ±0.06
Fats (%)	5.70 ±0.01	6.00 ±0.01	6.20 ±0.02
Ash (%)	0.70 ±0.01	5.10 ±0.04	5.50 ±0.03
Fibre (%)	0.20 ±0.00	0.90 ±0.01	0.70 ± 0.00
Calcium (Mg/100g)	108.3 ±0.66	192.3 ±0.69	248.1 ±0.67
Iron (Mg/100g)	34.8 ±0.09	30.0 ±0.11	24.0 ±0.10
Magnesium (Mg/100g)	24.9 ±0.07	40.2 ±0.04	42.1 ±0.08
Phosphorus (Mg/100g)	7.9 ±0.07	37.3 ±0.03	26.6 ±0.02
Zinc (Mg/100g)	1.9 ±0.00	1.8 ±0.01	0.64 ±0.00

Table 2: Proximate composition of muffin cakes

Nutrients	WTF (100:0)	WSU1 (75:25)	WSF1 (75:25)	WSU2 (50:50)	WSF2 (50:50)
CHO (%)	49.74^{a} ±1.00	43.48^{b} ±0.11	38.97^{c} ±0.12	34.93^{d} ±0.09	34.67^{d} ±0.11
Moisture (%)	30.40^{c} ±0.91	31.36^{b} ±0.21	31.28^{b} ±0.11	31.32^{b} ±09	35.60^{a} ±0.11
Protein (%)	18.10^{c} ±0.07	18.60^{bc} ±0.12	18.68^{b} ±0.07	18.88^{b} ±0.11	21.50^{a} ±0.09
Fats (%)	6.22^{c} ±0.06	6.50^{b} ±0.06	6.72^{a} ±0.05	6.80^{a} ±0.02	6.85^{a} ±0.06
Ash (%)	1.10^{e} ±0.03	2.60^{d} ±0.04	3.05^{b} ±0.02	2.90^{c} ±0.01	4.10^{a} ±0.00
Fibre (%)	0.70^{d} ±0.01	1.20^{b} ±0.00	1.30^{a} ±0.01	1.10^{c} ±0.02	1.30^{a} ±0.00

WTF= cake sample with 100% wheat flour, WSF1 and WSF 2= cake samples with 25% and 50% fermented sesame seed meal respectively, WSU1 and WSU2= cake samples with 25% and 50% unfermented sesame seed meal.

Mineral Composition of Muffin Cakes

The mineral composition of muffin cakes made from wheat and unfermented or fermented sesame seed meal blends are represented in Table 3 with significant ($p<0.05$) differences. The wheat flour (WF, control) had 116mg/100g calcium, 38.3mg/100g iron, 38mg/100g magnesium, 3mg/100g phosphorus and 8mg/100g zinc, while the 25% inclusion of unfermented (WSU1) and fermented sesame seed meal (WSF1) had 120-160mg/100g calcium, 36-46mg/100g iron, 14-24mg/100g magnesium, 5-24mg/100g phosphorus and 10-11mg/100g zinc. Also the 50% substituted unfermented (WSU2) and fermented sesame seed meal (WSF2) had 180-200mg/100g calcium, 36-51mg/100g iron, 24-28mg/100g magnesium, 16-35mg/100g phosphorus and 12-12mg/100g zinc, respectively.

Sensory Properties of Muffin Cakes

The scores for sensory attributes of muffin cake samples are shown in Table 4. Substitution of both fermented and unfermented sesame seed meal for wheat in the cake samples significantly ($p< 0.05$) decreased these sensory scores. The scores ranged from 5.10 to 6.45 for colour, 5.10 to 6.0 for flavour, 5.10 to 6.2 for texture, 4.90 to 6.10 for mouth feel and 4.95 to 6.3 for overall acceptability; with the highest values of these attributes for the control, 100% wheat cake. At the same levels, 25% or 50%,

Table 3: Mineral composition of muffin cakes

Minerals	WTF [100. 0]	WSU1 [75:25]	WSF1 [75:25]	WSU2 [50:50]	WSF2 [50:50]
Calcium (Mg/100g)	116.3^{e} ±0.08	120.2^{d} ±0.09	160.2^{c} ±0.10	180.3^{b} ±0.06	200.1^{a} ±0.11
Iron (Mg/100g)	38.3^{e} ±0.41	36.0^{d} ±0.32	46.0^{c} ±0.38	42.3^{b} ±0.28	51.2^{a} ±0.60
Magnesium (Mg /100g)	38.3^{a} ±0.22	14.2^{e} ±0.42	24.1^{c} ±0.32	20.3^{d} ±0.31	28.1^{b} ±0.32
Phosphorus (Mg/100g)	3.6^{e} ±0.01	5.3^{d} ±0.00	24.4^{b} ±0.02	16.4^{c} ±0.02	35.1^{a} ±0.03
Zinc (Mg/100g)	8.1^{e} ±0.06	10.3^{d} ±0.05	11.4^{c} ±0.06	12.0^{b} ±0.02	14.0^{a} ±0.05

WTF= cake sample with 100% wheat flour, WSF1 and WSF 2= cake samples with 25% and 50% fermented sesame seed flour respectively, WSU1 and WSU2= cake samples with 25% and 50% unfermented sesame seed flour.

Table 4: Sensory properties of muffin cakes

Samples	Colour	Flavour	Texture	mouth feel	overall acceptability
WTF (control)	6.45^{a}±0.69	5.90^{a}±1.3	6.2^{a}±0.78	6.10^{a}±0.80	6.30^{a}±0.73
WSF_1 (75:25)	6.35^{ab}±0.88	6.0^{a}±0.86	6.0^{a}±0.80	5.85^{a}±0.81	5.65^{b}±0.75
WSU_1(75:25)	5.90^{ab}±1.25	5.9^{a}±0.76	5.90^{a}±0.78	5.8^{a}±0.83	5.40^{b}±0.88
WSF_2(50:50)	5.70^{bc}±0.80	5.55^{ab}±0.83	5.75^{a}±0.91	5.55^{a}±1.05	5.25^{b}±1.12
WSU_2(50:50)	5.10^{b}±1.48	5.10^{b}±1.02	5.10^{b}±1.02	4.90^{b}±1.07	4.95^{c}±0.10

WTF= cake sample with 100% wheat flour, WSF1 and WSF 2= cake samples with 25% and 50% fermented sesame seed flour respectively, WSU5.10 to 1 and WSU2= cake samples with 25% and 50% unfermented sesame seed flour of sesame seed substitution, cakes with fermented sesame had higher sensory scores. Thus, fermented sesame improved sensory attributes of the cakes. However, cakes with the higher 50% sesame had lower sensory scores.

DISCUSSION

The results on proximate composition showed that the protein content of the wheat flour (11.22%) is within the range of 7 to 14% protein content of most cereal grain, including wheat grain reported by Enwere [2]. In this study, fermentation increased the protein, fat and ash contents of the sesame seed meal from 13.56%, 6.0%and 5.10% to 14.20%, 6.20% and 5.5%, but caused a decrease in carbohydrate content from 42.14% to 30.40%, respectively (Table 1). The reduction in carbohydrate content was likely due to conservation of complex carbohydrates to simpler once by - and - amylases during fermentation, also in the utilization of carbohydrate by fermenting microorganisms [20, 21]. In a similar manner, the increase in protein content may be due to hydrolysis and conversion of complex organic nitrogen compounds to simpler once as fermentation progressed [22, 23, 24]. Thus, fermentation significantly ($p<0.05$) improved the nutrient composition of the sesame meal.

Fermentation process is known to improve nutrient composition of food [21, 22, 25]. Although the Ca, Mg and P contents were high in the sesame seed meal than in wheat flour, fermentation further increased Ca and Mg contents in the sesame. On the other hand, Fe and Zn contents decreased in the same fermented sesame meal, suggesting presence of soluble salts of these metals and their solubilisation in the fermenting medium.

Sesame seed (unfermented and fermented) meal improved the nutrient composition of cake (Table 3). Substituting 25% and/or 50% of unfermented and fermented sesame seed meal for wheat flour significantly ($p>0.05$) increased the protein, fat, ash and fibre contents by about 5.7 to 6.2%, 6.30 to 9.7%,157 to 218% and 71 to 78.6% in the produced cake samples (Table 3). Therefore, the sesame meal inclusion had a positive increase in the nutrient composition of the cakes. However, the carbohydrate (49.74%) content of the 100% wheat cake was higher than the 34.93% and 34.67% carbohydrate content obtained in cake samples with 50% substituted unfermented and fermented sesame seed meal, respectively. The reverse was the case for the protein, fat, ash and fibre contents which increased with the 50% substitution of unfermented and fermented sesame meal. The results on proximate composition of cakes imply that supplementing muffin cake with sesame seed meal (unfermented and fermented) improved its nutrient composition [26].

The 25% and/or 50% unfermented or fermented sesame seed meals were responsible for the increased calcium, iron, magnesium, phosphorus and zinc contents of the cake samples. However, magnesium was higher in the wheat flour, probably due to its low content in the unfermented and sesame seed meal [27, 28].

The high sensory scores for 100% wheat cake could be due to the assessors' familiarity and long-time consumption of wheat and wheat products. This 100% wheat bread had lower nutrient composition; the assessors did not know this. Although at this level (25%) and below, the nutrient content of cake samples increased, implying higher nutrient quality than the control (100% wheat).

CONCLUSION

The evaluation of the effect of substituting unfermented and fermented sesame seed meal with wheat flour in the production of muffin cakes was established in this study. Substitution of wheat flour with unfermented and fermentation sesame seed meal increased the nutrient density of muffin cakes, especially, the proximate and mineral compositions. However, cake samples with 50% substituted unfermented or fermented sesame seed flours were less preferred by panellists. Sesame seed is under-utilized and readily available in Nigeria, and are have high potential nutrients to supplement with wheat flour for muffin cake production for high nutrient content and acceptable products.

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REFERENCES

1. O'Brian, E. D. (2003). Effects of varying the micro-encapsulation process on the functionality of hydrogenated vegetable for in short dough biscuit. Food Regulation International, 3b: 215-217.

2. Enwere, N.J. (1998). Foods of Plant Origin: Processing and Utilization with Recipes and Technology Profiles. Nsukka, Afro-Orbis publications Ltd, pp. 83-90.

3. Ihekoronye A. I. and PO Ngoddy (1985). Integrated Food Science and Technology for the Tropics. London, Macmillan publishers, pp 259-

262.
4. Becker, D., Folck, A., Knies, P., Lörz, H., and Wieser, H. (2006). Silencing the -gliadins in hexaploid bread wheat. In: G. L. Lookhart & P. K. W. Ng editors. Gluten proteins. A.A.C.C. International; St. Paul,M. N: 86-89.
5. Watson F., Stone M.,Bauer L. and Bunning M., (2017). Gluten free baking. Food and Nutrition Series/health, Fact Sheet NO. 9.376.
6. Cook, F. and Briggs, G. M. (1997). Nutritive value of eggs, In W.J, Slademan & P. J., Cotterils (eds), Egg Science and Technology, (pp. 92-108), 2nd ed., Connecticut, Avi publ. Co, pp. 92-108.7. Onweluzo, J. C., Onuoha K. C., and Obanu, Z. A.(1995). A comparative study of some functional properties of Afzelia Africana and Glycine max flours. Food Chemistry, 54: 55-59.
8. Giami, S. Y., Amasisi, T. and Ekiyo, G. (2004). Comparison of bread making properties of composite flours from kernel of roasted and boiled African breadfruit (Treculia africana Decne). Journal of Raw Material Research, 1(1): 16-25.
9. Oluwole, O. B., andKarim, O.K. (2005). Production of biscuit from bambara, cassava and wheat flour blends. Journal of Raw Material Research, 2(1): 34-38.
10. Pohjanhemo, T. A., Hakala, M. A., Tahvonen, R. L., Salminen, S. J., and Kllio, H. P. (2006). Flaxseed in bread making: effects on sensory quality, aging, and composition of bakery products. Journal of Food Science, 71(4): S343-S348.
11. Parades, I. O., Gazman, M. S. H. and Ordorica, B. C. (1994). In Hudson, B. J. (Ed). Food Proteins from Emerging Seed Sources in New and Developing Sources of Food Proteins. London, Elsevier Applied Sciences, pp. 241-262.
12. Grenot, k. (1999). Sesame seed aroma, pp. 11 www.uni-graz.at/katzer/eng/sesa-ind.htm/H Retrieved on the 20th of March, 2010.
13. Anon (2000). Growing sesame production tips, Economics and more. Retrieved from www.Jeffersoninstitute.org/pubs/sesame/snumi.August 22, 2011.
14. Gandi, A. P. (2007). Studies on the production of protein isolates from defated sesame seed (Sesamum indicum) flour and their nutritional profile. ASEAN Food Journal 14(3): 175-180.
15. Abou-Gabia, H. A., Shebuta, Al-Mahah, K. and Shahidi,Asoud,H., (2002).Rheological characterisation of milled sesame (Tabineh). Food Hydrocolloids, 16:5 5-67.
16. Rahman, S. A., Mohammed, S. E.andEbayaya, M. (2007). Sesame production, processing and marketing in Nasarawa State of Nigeria. A Report of consultant submitted to GTZ,pp 34.
17. AOAC (2000).Association of Official Analytical Chemists. Official methods of analytical Chemists. 18th ed. Washington DC,pp 18-62.
18. Melligard, M. C., Carville, G. V. andCart, E. T. (1999). Sensory Evaluation Techniques 4th edn. Bocaroton, Fl: CRC press Inc.
19. Onwuka, G. I., (2005). Food Analysis and Instrumentation. Lagos, Naphthalie prints - a division of HG Nigeria limited.
20. Sohliya, I., Joshi, S. R., Bhagobaty, R. K. and Kumar, R. (2009). Tungrymbai- A traditional fermented soybean food of the ethnic tribes of Meghalaya. Indian Journal of Traditional Knowledge, 8: 559-561.
21. Jeyaram, K., Mohendro Singh, W., Premarani, T., Devi, A.R., Chanu, K.S., Talukdar, N.C. and Singh, M.R. (2008). Molecular identification of dominant microflora associated with 'Hawaijar'da traditional fermented soybean (Glycine max (L.)) food of Manipur. India. International Journal of Food Microbiology, 22:259-68.
22. Claughton, S. M. (1989). Pearce RJProtein enrichment of sugar-snap cookies with sun flour protein isolates. Journal of Food Science, 54: 354 - 359.
23. Iyer, B. K., Singhal, R.S. and Ananthanarayan, L. (2013). Characterization and in vitro probiotic evaluation of lactic acid bacteria isolated from idli batter. Food Science and Technology, 50:1114-21.
24. Palanisamy, B. D., Rajendran, V., Sathyaseelan, S., Bhat, R. and Venkatesan, B. P. (2012). Enhancement of nutritional value of finger millet-based food (Indian dosa) by co-fermentation with horse gram flour. International Journal of Food Science and Nutrition, 63:5-15.
25. Rahabah, T. M.., Manasneh, M. A, and Ereifej, K. I. (2006). Effect of chickpea, broad bean or isolated soy protein addition on physicochemical and sensory properties of biscuits. Journal of Food Science, 71(6): S 438 – S 442.
26. Plessas, S., Pherson, L., Bekatou, A., Nigarn, P. and Koutinas, A. (2005). Bread making using kefir grains as baker's yeast. Food Chemistry, 93: 585-589.
27. Achinewhu, S. C. and Isichei, M. O. (1990). The nutritional evaluation of fermented fluted pumpkin seeds (Telfairia occidentalis Hook). Discovery and Innovations, 2: 62-65.
28. Akubor, P. (2003). Functional properties and performance of cowpea and performance of cowpea/plantain/wheat flour blend in biscuit/cookies. Plant Food for Human Nutrition, 58:1-8.