Nutritional Composition And Energy Value Of Roasted Peanut Milk Partially Substituted With Millet Thin Porridge Fermented With Bifidobacterium Longum BB536

Salma Elzen Ibraheem, Barka Mohammed Kabeir, Limia Hashim Mohammed, Bhageil Taifour Bhagiel

Department of Food Science and Technology, College of Agricultural Studies
Department of Animal Production College of Agricultural Studies
Sudan University of Science and Technology, Khartoum, Sudan
Tel: 0029904470439, Fax: 00249 311896,
E-email: barakamohamed@sustech.edu

Abstract: This study was carried out to determine the nutritional value of different roasted peanut based milk fermented with B. longum BB536. Roasted peanut and yellow millet were soaked in water (12 h), blended (5 min) and filtered using a double layered cheese cloth to prepare the roasted peanut milk and millet beverage, which was boiled to prepared millet thin porridge. Different formulation based on roasted peanut milk partially substituted with 15% (A), 30% (B), and 45% (C) with millet thin porridge was prepared. Formulations were sterilized (121˚C for 15 min), inoculated (3% active culture of B. longum BB536), and incubated (37 ◦C) for 18 h. Proximate composition was determined and energy value was calculated. Roasting facilitated the removal of the crust and decreased the peany flavor of peanut. The improvement in fat, proteins, fiber, ash and Carbohydrates of peanut by roasting was 0.23, 1.43, 0.32, 0.1, and 0.62%, respectively; due to decrease in moisture by roasting. Roasted peanut contains higher fat, protein, while in raw millet higher fiber, ash and carbohydrates have been recorded. The number of B. longum BB536 obtained in all fermented beverages was above the number required to presence in probiotic food which is at least 6 log CFU/ml. Fermentation increased moisture, protein, ash and fiber in peanut milk. While fat, carbohydrate and total soluble solids decreased. Fermentation increased protein, ash, fiber, total soluble solid, and carbohydrate but decreased moisture and fat in millet thin porridge. Fermentation increased moisture, and fiber but decreased fat, carbohydrate, and total soluble solid in blends A, B, and C. Protein and ash increased in blend A. The calculated energy value ranged from 61.19 kcal/100ml in peanut milk to 36.18 kcal/100ml in Blend C. It decreased by supplementation with millet thin porridge. However, serving with sugar could fulfill the daily energy requirements for adult men (3200 kcal) and adult women (2300 kcal). The fermented beverages fulfill probiotics requirement and provide energy and other essential nutrients.

Keywords: Peanut milk, millet porridge, fermentation, Bifidobacterium, Nutritional, energy value.

INTRODUCTION

Food fermentation is one of the oldest known uses of biotechnology. All over the world, fermented foods continue to constitute an important part of our diet and together with beverages are estimated to present some 20-40% of our food supply world-wide [1]. Particularly in developing countries, where refrigeration is not always an option, the fermentation process is widely used. Fermentation prolongs the shelf-life of foods in addition to improving the nutritional value and reducing the risk for food borne illness [1]. Cereal and legumes are mostly used to develop fermented beverages .Fermented foods can even have beneficial health effects, when microorganisms used possess probiotic activity. The word probioticis derived from Greek and means“for life” [2]. One of the more detailed current definitions of probiotics is; “a microbial dietary adjuvant that beneficially affects the host physiology by modulating mucosal and systemic immunity, as well as improving nutritional and microbial balance in the intestinal tract”. Mainly specific strains of lactobacilli, Bifidobacterium, enterococci and yeast are today used commercially as probiotics [3, 4, 5]. Bifidobacterium are considered as important probiotics and used in the food industry to relieve and treat many intestinal disorders. Bifidobacterium exert a range of beneficial health effects, including the regulation of intestinal microbial homeostasis, the inhibition of pathogens and harmful bacteria that colonize and/ or infect the gut mucosa, the modulation of local and systemic immune responses, the repression of procarcinogenic enzymatic activities within the microbiota, the production of vitamins, and the bioconversion of a number of dietary compounds into bioactive molecules [6]. Bifido bacteruim longum may be considered the most common species of Bifidobacterium, being found both in infant and adult feces [7]. Potential benefits from consumption of B. longum include: antagonistic action toward intestinal pathogens, improved lactose utilization, anticarcinogenic action and control of serum cholesterol levels. Many scientific studies showed the benefits offered by Bifidobacterium longum BB536 [8, 9]. Thus there is considerable interest in incorporating these heaths promoting bifidobacterium into food. On the other hand Dairy products are the main carriers of probiotic bacteria to human, as these products provide a suitable environment for probiotic bacteria that support their growth and viability. However, with an increase in the consumer vegetarianism throughout the developed countries, there is also a demand for alternative carrier for beverage. The development of new nondairy probiotic food products is very much challenging, as it has to meet the consumer’s expectancy for healthy benefits [10]. Nevertheless, there were no many studies regarding application of probiotic bifidobacterium into fermented Sudanese foods. In previous investigation [11] successfully incorporated B. longum BB536 into Sudanese cereal beverage Medida. Legumes (Arachis hypogaea L.) groundnut has a potential role in combating malnutrition are a major source of edible oil and protein meal and therefore considered to be highly valuable in human and animal nutrition [12]. It’s rich in protein, energy and other

nutrient. peanut- based formulated food can be developed to for a therapeutic purposely and to aid in famine relief .There for the present low level in peanut consumption, especially in the developing countries ,should be increased. It is, therefore, necessary to direct research into the possibility of peanut processing into other useful and edible products. Fermentation of groundnut milk may serve as one such effort that can increase the protein availability and consumption [13]. On the other hand, millet is the sixth most important grain in the world. Millet is equal or superior to grain of wheat, corn sorghum and rice in protein and oil content, it contains similar amount of calcium (Ca) and phosphorus (P), more iron (Fe) than the cereals grains [14]. Millets have an alkaline pH and are the only grains that keep their alkaline properties even after being cooked. As another plus, millet is a gluten free grain and thus, is ideal for people with wheat/gluten allergies or intolerance [15]. In this respect, the use of peanut milk and millet blend will complement nutrients same time can be a successful non-dairy carriers for Bifidobacterium strain. There for the objective of this study are to determine the nutritional value of the different Bifidobacterium BB536 fermented beverages.

MATERIALS AND METHODS

Raw Materials

The red-skinned peanut seeds (Arachis hypogaea) (V. Natal) were purchased from a local crops market in Bahri (Kartoum State, Sudan). Care was taken to ensure that good quality and mould-free seeds were selected. The yellow millet (Panicum miliaceum) (V. Proso) was purchased from Alzraiga village (Eldwaim, White Nile State, Sudan). Fresh cow milk control was obtained from Department of Animal Science, Collage of Agriculture Studies, Sudan University of Science and Technology (Khartoum, Sudan).

Preparation of peanut milk

Peanut milk was prepared by a similar method to the one reported by Salunkhe and Kadam [16] with slight modifications. Sorted peanut seeds were roasted at 100°C for 20 min in an oven ((Baird & Tatlock (London) LTD. Chadwell – Heat. Essex. England).The roasting process was found to improve nutrient component, facilitate the removal of the crust and decrease the peany flavor of peanut .The roasted peanut were then de-skinned and weighed before being soaked in water for at least 12 h. The de-skinned roasted peanut kernels were then washed with clean distill water. The roasted kernels were then mixed with water in a ratio of 1:5w/w [peanuts (200g): water (1L)] and transferred to a blender (Panasonic – MX – 101 SP2), where they were blended for 5 min at medium speed .The slurry formed was filtered using a double layered cheese cloth to prepare the peanut milk.

Malting of millet

The yellow millet was malted following the procedure reported by Kabeir et al. [11]. Cleaned millet were washed and soaked in twice its volume with distilled water in 2l beakers, and placed in a temperature-controlled water bath (Scott- Science UK. Model LWB – 122D –Serial N O. 06122858) at 30°C for 12 h. Water was renewed every 6 h during the soaking period to avoid fermentation. For germination, the millet were spread on aluminum dishes and incubated for 48 h at 30°C. During the germination period the millet were turned and rinsed every 12 h with distilled water to promote aeration and prevent mould development. Germinated millet were dried in an oven at 50°C for 48 h, after that the roots of the germinated millet were removed and the malted millet were ground into a flour and sieved through a 355-µm screen. The flour was packed in a plastic container and kept at refrigeration temperature until used.

Preparation of millet thin porridge

Yellow millet thin porridge was prepared according to procedure by Kabeir et al. [11], with some modifications. 200g cleaned yellow millet was weighted, washed and soaked in 400 ml distilled water in 2l beaker, and placed at room temperature for 7 h .Water was drained and millet was blended with 800ml clean water at medium speed for 5 minutes. The slurry formed was filtered using a double layered cheese cloth and boiled in hot plate at 70˚C for 3 min magnetic stirrer was used for mixing .Malted millet flour was added in ratio 1:5 w/w after cooling at 37 ˚C and maintain for 14 min to prepared millet milk with low viscosity and flowing characteristics in addition TSS was high recording values of 6%.

Preparation of fermentation inoculums

B.longum BB536 was obtained from the stock culture of microbiology laboratory (Department of Food Science and Technology, Collage of Agriculture Studies, Sudan University of Science and Technology. The strain was maintained at -20 ˚C in 20% glycerol solution. Stock culture was prepared by activation of the strain in skim milk, incubated an aerobically at 37 ˚C for 24h. The obtained culture was re-activated again under the same conditions to prepare enough stock for the experiment. The working culture was prepared by twice successive transformation in 10% sterilized skim milk (121˚C for 15 min) and incubation at 37 ˚C for 24 h.

Growth medium and fermentation conditions

Growth medium were formulated from fresh cow milk, pure peanut milk, millet thin porridge in addition to three different blends based on peanut milk prepared by partial substitution of (A), (B), (C) with millet thin porridge. Formulated medium were sterilized (121˚C for 15 min) and inoculated with a 3% active culture of B. longum BB536 followed by incubation at 37 ◦C for 18 h.

Enumeration of viable cell

MRS medium was used to enumerate B. longum BB536 of different fermented beverages using the plate count technique. Fermented Samples were drawn at initial and every 6h intervals during fermentation. One ml of fermentation broth was diluted in peptone water, followed by plating on De Mann Rogosa agar (MRS) supplement with 0.05% L- cystiene. The plates were incubated an aerobically at 37 ˚C for 48 h. The strain viable count was calculated as Colony Forming Unit per ml (CFU/ml).

Chemical composition

Determination of moisture content

Moisture was determined according to the modified method of AOAC [17]. 5grams of the sample was weight in sensitive balance, after weighting the dishes was transferred to an oven (Kat-NR. 2851, Electrohelios, Sweden) at 105 ± 0.1˚C for 6 hours. Afterwards, the dish with sample was transferred to desiccators and allows to cool at room temperature before reweighting to calculate moisture content.

Determination of fat content

Fat content was determined according to the official method of AOAC [17]. A sample of 5g was weighed into an extraction thimble and covered with cotton, and then extracted with hexane. The thimble containing the sample and a pre-dried weight extraction flask containing about 100 ml hexane was attached to the extraction unit. The extraction process was conducted for 16h. At the end of the extraction period, the flask was disconnected from the unit and the solvent was evaporated. Later, the flask with the remaining crude hexane extracted was put in an oven, cooled to room temperature, re-weighing and the dried extract was registered as fat content.

Determination of protein content

Protein content of different fermented beverages was determined by Kjeldhal method according to the AOAC [17] method. Two gram of the different fermented products were weighed in a crucible and transferred to a digestion flask with two tablets catalyst (mercury). 25 ml of concentrated sulphuric acid were added to the samples, the flask was placed on the digestion apparatus, heated until the mixture was colour less, and then were allowed to cool. 25 ml of boric acid and three drop of bromocresol green+ methyl red indicator were added to each receiving flask. The digested samples were transferred from the digestion flask to volumetric flask and the volume was completed to 100 ml by distilled water. The receiving flask was placed on the distillation rack with the tip of the condenser extended below the surface of the acid. Immediately 5 ml of the diluted samples were added from the funnel of the distillation apparatus, then 10 ml NaOH (40%) was gently added. The distillation was continued until the volume in the receiving flasks were 7 ml, then the flask were removed from the distillatory. The samples in the receiving flask were titrated against 0.1 N HCL until the colour changed from green to purple, then the nitrogen content was calculated.

Ash content

The ash content of samples was determined according to the AOAC [17] method. A 2g of the deferent fermented beverages were weighed into a clean dry porcelain crucible and placed in muffle furnace (model Tipoforon Z A No 18203 Get Ran 1002) at 600˚C for 6 hours. The Crucible was transferred to desiccators, cooled to room temperature, weighed and then the ash content was calculated.

Determination of crude fiber

Fiber was determined according to official method of AOAC [17]. Two g of a defatted sample was placed into a conical flask containing 200ml of H2 SO4(0.26N). The flask was fitted to a condenser and allowed to boil for 30 minutes. At the end of the digestion period, the flask was removed and the digestate was filtered through a proclaim filter crucible (No.3). After that, the precipitate was repeatedly rinsed with distilled boiled water followed by boiling in 200ml NaOH (0.23N) solution for 30 min under reflux condenser and the precipitate was filtered. Rinsed with hot distilled water, 20 ml ethyl alcohol (96%) and 20ml diethyl ether. Finally, the crucible was dried at 105 Cº until a constant weight was obtained and the difference in weight was considered a crude fiber.

Calculation of carbohydrates

Carbohydrates were calculated by difference according to the following:

Total carbohydrates = 100% - [Moisture (%) + Protein (%) +Fat (%) + fiber (%) and Ash (%)].

Statistical analysis

Two sample paired test were performed to examine significant differences between normally distributed data of replicated measurement. Probability level of less than 0.05 was considered significant ($p<0.05$). All data were analyzed using vision 16 MINITAB statistical software for windows [18].

RESULTS AND DICUSSION

Chemical composition of the raw peanut and Millet

A result of the proximate composition in table (Table 1) shows that raw peanut contains higher fat, protein. While in raw millet higher fiber, ash and carbohydrates have been recorded. Thus they can complement each other if formulated in one recipe. Referring to composition of reference peanut in Tabl1 1, moisture content was similar to the analyzed raw peanut sample; however, fat, protein, and carbohydrate were higher in row peanut when ash and fiber were higher in reference peanut. On the other hand raw peanut was higher in protein and carbohydrates as compared to composition of reference millet. These variations between raw and reference values might be due to the variety of species, production method, storage condition and harvesting phase. Roasting of peanut improved fat, protein, fiber, ash, and carbohydrate due to decrease moisture after the process. Moisture content of raw peanut was 6.13, decreased to 3.42 after roasting processes. However, the process increased fat, proteins, fiber, ash and Carbohydrates of peanut by 0.23, 1.43, 0.32, 0.1, and 0.62% respectively. These results on composition of roasted peanut are in agreement with those reported by Abayomi et al. [19] and Adegoke et al. [20].

The growth of Bifidobacterium longum BB536 during fermentation of different formulated beverages

Comparative growth of Bifidobacterium longum BB536 cultured in different beverages (cow milk, peanut milk, millet thin porridge and different blends) is shown in table 2. There were significant ($p<0.05$) increases in B. longum BB536 viable count by extended fermentation period in all type of formulated beverages, as compared to strain level at beginning of fermentation. The maximum growth of B. longum BB536 was attained at 18h in all type of fermented beverages, except in fresh cow milk it was attained at 12 h fermentation. After the maximum growth, the strain declined in all types of fermented beverages (Table 2). The rate of B. longum BB536 increases in different fermented beverages

were 3.15, 2.9, 2.89, 2.76, 2.43 and 2.1 CFU/ml in fermented peanut milk, millet thin porridge, cow milk, blend (B), blend (A), and blend (C), respectively. These variations in growth could be attributed to variances in availability of nutrients required for growth in different fermented beverages. Peanut contains almost the essential nutrient for strain growth. Combination of peanut with millet could complement the nutrient component of growth medium. However, the growth of strain B. longum BB536 was affected by supplementation with millet milk (table 2), that could be due to increase viscosity of beverages by supplementation with millet milk. The viable count of B. longum BB536 in all types of fermented beverages still above the number required to presence in probiotic food which is at least 6 log cfu/ml fermented products [21].

Chemical composition of different beverages fermented with growth of Bifidobacterium longum BB536 time

Table 3 shows the chemical composition of peanut milk and millet milk beverages fermented with B. longum BB536 at initial (0h) and maximum growth time (18h). The result presented in table 3, revealed that there were no significant ($p<0.05$) changes in compound of beverages .In fermented peanut milk there were increases in moisture, portion ,ash and fiber; while fat, carbohydrate and total soluble solids decreased by fermentation (Table 3). Moreover, In fermented millet then porridge there were increases in portion , ash, fiber, total soluble solid, and carbohydrate; while moisture and fat decreased by fermentation. In different blends (A, B, and C) moisture, and fiber increased but the fat, carbohydrate, and total soluble solid decreases by fermentation. The protein and as increased in blend A and decreased in blend B and C.

The energy value of fermented beverages

The energy value of different fermented beverages is presented in Table 5. The calculated energy ranged from 61.19 kcal/100ml in peanut milk to 36.18 kcal/100ml in Blend C. The energy decreased by thin porridge supplementation. For adult men would need to ingest at least 5 L, 9 L ,8 L ,7 L and 9L of fermented beverages peanut milk, millet thin porridge, blend (A) ,blend (B) and blend(C) respectively. While adult women need to ingest at least 4 L, 6 L ,5 L ,5 L and 6 L of fermented peanut milk, millet thin porridge ,blend (A),blend (B) and blend(C), respectively. The amount to be intake daily to meet the daily energy requirements for adult men (3200 kcal) and for adult women (2300 kcal)) as recommended by FAO/WHO/BULL [22]. The addition of sugar will reduce the amount required to meet the daily energy requirements.

Conclusion:

Peanut and millet are rich source of protein and carbohydrates. Fermentation with probiotic Bifedobacterium longum BB536 is of potential, sufficient viable numbers was obtained in different types of fermented beverages. Improvement in protein, TSS was recorded. The fermented beverages can provide enough energy to elderly men and women. This study can facilitate the development of non-dairy probiotic product with improved nutritional and energy value. More researches to be conducted on sensory characteristics and functional properties of the fermented beverages to explore consumer preferences and product health benefits.

Acknowledgments

We duly acknowledge the financial support (Research Grant) received from Deanship of Scientific Research, Sudan University of Science and Technology.

REFERNCES

[1] Campbell-Platt, G. (1994). Fermented foods – a world perspective. Food Research International 27: 253-257.

[2] Metchnikoff, E. (1907). The prolongation of life: Optimistic studies. London: Butterworth-Heinemann.

[3] Naidu, A.S., Bidlac, W.R and Clemens, R.A. (1999). Probiotic spectra of lactic acid bacteria. Critical Reviews in Food Science and Nutrition 38: 13-126.

[4] Holzapfel, W.H., Geisen, R., Schillinger, U. (1995). Biological preservation of foods with reference to protective cultures, bacteriocins and food-grade enzymes. International Journal of Food Microbiology 24: 343 – 362.

[5] Saxelin, M., Tynkkynen, S., Matilla-Sandholm, T., and DeVos, W.M. (2005). Probiotic and other functional microbes from markets to mechanisms. Current Opinion in Biotechnology 16 (2): 204 – 211.

[6] Mayo, B., van Sinderen, D. (2010). Bifida bacteria : Genomics and Molecular Aspects. Caister Academic Press . ISBN 978-1-904455-4.

[7] Bivati, B., Castagnoli, P. and Trovatelli, L.D. (1984). Species of the genus Bifedobacterum in the feaces of human adults. Microbilogical 9: 39 – 45.

[8] Kojima, T., Yaeshima, T., Ishibashi, N., Shimamura, S., Hayasawa, H. (1996). Inhibitory effects of human-drived bifidobacterium on pathogenic Escherichia coli serotype O-111. Bioscience Microflora 15: 17 – 22.

[9] Namba, K., Yaeshima, T., Ishibashi, N., Hayasawa, H., Yamazaki, S. (2003). Inhibitory of Bifidobacterium longum on inter hemorrhagic Escherichia coli O157: H7. Bioscience Microflora 22: 85 – 91.

[10] Stanton, C., Desmond, C., Coakley, M., Collins, J.K., Fitzgerald, G., Ross, R.P. (2003). Challenges Facing Development of Probiotic-Containing Functional Foods. In: Farnworth E, editor. Handbook of Fermented Functional Foods. Boca Raton: CRC Press., pp 27-58.

[11] Kabeir, B.M.,Abd Aziz, S,Muhammad, M and Yazid, A.M. (2005). Growth of B.ifidobacterium longum BB536 in Medida (fermented cereal porridge) and their survival during storage. lett. Appl. Microbiol. 41:12 - 131 .

[12] Nwokalo, E. (1996). Peanut (Arachis lypogaeaL.) In: Nwokolo E, Mart, J.S. (Eds.). Legumes and oilseeds in nutrition. Chapman and Hall, London,pp 49.

[13] Roberts-Sunny, E.O., Ofunda, E.T and Iwakun, B.T. (2004). An evaluation of some quality parameters of laboratory-prepared fermented groundnut milk. J. Eur. Food Res. Technol. 218: 452-455.

[14] Marwa, El-Gazzar .,M. (2005). Biochemical and technological studies on millet. M.Sc. Thesis, Agric. Sci. (Biochemistry), Faculty of Agriculture, Cairo University.

[15] Baltensperger ,D. and Cai Y.Z. (2004). Minor Millets In Encyclopedia of Grain Science, C.W.Wrigley, H. Corke and C.E. Walker, (eds.), Vol. 2, p. Pages 261-268. Oxford, U.K.

[16] Salunkhe, D.K and Kadam, S.S. (1989). Handbook of World Food Legumes: Nutritional Chemistry, Processing Technology and Utilization. 1st Edn., CRC Press. Inc., Boca Raton.Floridea.323.

[17] AOAC. (1990). Official Methods for Analysis (15th ed). Association of Official Analytical Chemists. Washington, D.C., USA.

[18] MINITAB. (2006). Statistical software, Release 14 for Windows, minitab Inc, USA.

[19] Abayomi, P., Isaac, Ayodele, A. (2002). Effects of processing conditions and packaging materials on the quality attributes of dry-roasted peanuts. J. Food Sci.Agric. 82: 1465-1471.

[20] Adegoke, G. O., Falade, K.O., and Babalola, O. C . (2004). Control of lipid oxidation andfungal spoilage of roasted peanut (Arachis hypogaea) using the spice Aframomum danielli . Food . Agric . Environ . 2(1): 128-131.

[21] Vinderola, C. G., Bailo, N., Reinheimer, J. A. (2000). Survival of probiotic microflora in Argentinian yoghurts during refrigerated storage. Food Research International V. 33, n. 2, p. 97-102.

[22] FAO/WHO. (1979). Energy and protein requirements. Bulletin of the world health organization 57(1):65-79.

[23] Barbara Stadlmayr, U., Ruth Charrondiere, Victor ,N., Enujiugha- Romaric., G Bayili,Etel, G., Fagbohoun, Babacar Samb, Paulina Addy, Ingrid Barikmo, Fatimata Ouattara, ArneOshaug, Isaac Akinyele,George AmponsahAnnor, Kennedy Bomfeh, Henrietta EneObong, Ifeyironwa Francisca Smith, Ismael Thiam,BarbaraBurlingame. (2012).West African Food Composition Table, PP: 25-74.

Table 1. *Proximate composition of raw peanut and millet**

Components (%)	**Raw peanut and millet**				
	Raw Peanut	**Roasted peanut**	**Peanut reference values****	**Raw Millet**	**Millet reference values ****
Moisture	6.13 ± 0.21	3.42 ± 0.18	6.00 ± 1.70	8.41 ± 0.023	11.6 ± 0.7
Fat	48.14 ± 0.25	48.37 ± 0.31	45.90 ± 3.00	3.85 ± 0.32	4.1 ± 0.7
Proteins	25.17 ± 0.31	26.60 ± 0.44	22.40 ± 1.60	13.01 ± 0.08	10.9 ± 1.00
Fiber	2.08 ± 0.15	2.40 ± 0.20	8.50 ± 7.70	2.25 ± 0.09	8.8 ± 1.00
Ash	1.13 ± 0.13	1.23 ± 0.15	2.30 ± 0.10	1.64 ± 0.06	2.00 ± 1.9
Carbohydrates	17.36± 1.047	17.98 ± 0.58	14.60 ± 0.10	70.85 ± .46	62.6 ± 0.00

*Values are mean ± SD for replicate independent runs.
**Values from food composition table (Barbara, *et al.* [23].

Table 2. *The viable count of Bifidobacterium longum BB536 log (CFU/ml) during fermentation period of different beverages**

	Bifidobacterium longum BB536 **growth in beverages****

Time(h)	Cow milk	Peanut milk	Millet thin porridge	A	B	C
0	4.8 ± 0.12[a]	5.68 ± 0.10[d]	4.89 ± .06[d]	5.51 ± .05[e]	4.84 ± 0.08[d]	4.53 ± 0.07[d]
6	5.84 ± 0.15[b]	6.96 ± 0.04[c]	5.61 ± 0.18[c]	5.89 ± 0.02[d]	5.78 ± 0.07[c]	4.92 ± 0.04[c]
12	7.69 ± 0.14[c]	7.85 ± 0.056[a]	6.89 ± 0.06[a]	7.66 ± .11[b]	6.95 ± 0.04[b]	5.77 ± 0.09[b]
18	6.86 ± 0.11[d]	8.83 ± 0.07[b]	7.79 ± 0.06[b]	7.94 ± .05[a]	7.60 ± 0.08[a]	6.63 ± .04[a]
24	6.03 ± 0.01[d]	7.60 ± 0.08[b]	6.68 ± 0.11[b]	6.85 ± .02[c]	6.77 ± 0.09[b]	5.77 ±0.01[b]

* Values are mean ± SD for replicate independent runs.
** Values that bear different superscript letter in the same Colum are significantly different at p<0.05.
A=Blend1 was prepared using 85% peanut milk and 15% millet thin porridge.
B= Blend 2 was prepared using 70% peanut milk and 30 % millet thin porridge.
C= Blend 3 was prepared using 55% peanut milk and 45% millet thin porridge.

Table 3. *Chemical composition of beverages fermented with Bifidobacterium longum BB536*

Component (%)	peanut milk		millet thin porridge	
	Initial growth time	Maximum growth time	Initial growth time	Maximum growth time
Moisture	87.37 ± 0.37[a]	88.00 ± 0.01[a]	92.41 ± 0.27[a]	91.87 ± 2.50[a]
Fat content	2.90 ± 0.04[a]	2.83 ± 0.08[a]	1.54 ± 0.18[a]	1.18 ± 0.02[a]
Protein	3.11 ± 0.13[a]	3.450 ± 0.14[a]	1.90 ± 0.02[a]	1.95 ± 0.05[a]
Ash	0.19 ± 0.01[a]	0.21 ± 0.01[a]	0.09 ± 0.00[a]	0.18 ± 0.02[a]
Total solid	12.63 ± 0.20[a]	12.00 ± 0.07[b]	7.59 ± 0.27[a]	8.13 ± 2.50[a]
Carbohydrates	6.53 ± 0.18[a]	5.48 ± 0.104[a]	3.91 ± 0.45[a]	4.66 ± 2.49[a]
Fiber	0.017 ± 0.00[a]	0.032 ± 0.00[a]	0.15 ± 0.03[a]	0.16 ± 0.01[a]

* Values are mean ± SD for replicate independent runs.
** Values that bear different superscript letters in the same raw of each specific beverage are significantly different at p<0.05

Table 4. *Chemical composition of different blended beverages fermented with Bifidobacterium longum BB536 growth time**

	Type of blend

Component (%)	A		B		C	
	Initial growth time	Maximum growth time	Initial growth time	Maximum growth time	Initial growth time	Maximum growth time
Moisture	88.83±0.14[a]	89.96±0.20[b]	89.90±0.05[a]	91.39±0.58[a]	90.15±0.12[a]	93.28±0.88[a]
Fat content	2.78±0.05[a]	2.20±0.02[b]	2.60±0.09[a]	2.32±0.00[a]	2.17± 0.01[a]	2.14±0.03[a]
Protein content	2.70±0.16[a]	2.83±0.01[a]	2.72± 0.0[a]	2.67±0.07[a]	2.34 ±0.05[a]	2.27±0.07[b]
Ash content	0.17± 0.00[a]	0.18±0.00[a]	0.18±0.02[a]	0.17±0.02[a]	0.18± 0.01[a]	0.17±0.00[a]
Fiber	0.08±0.00[a]	0.13±0.05[a]	0.09±0.00[a]	0.17±0.00[b]	0.19±0.00[a]	0.18±0.00[a]
Carbohydrates	5.43±0.07[a]	4.70±0.24[a]	4.52±0.066[a]	3.30±0.48[a]	4.93± 0.08[a]	1.955±0.90[a]
Total solid	11.17±0.14[a]	10.04± 0.2[b]	10.10±0.049[a]	8.61±0.58[a]	9.85 ±0.12[a]	6.718±0.88[a]

* Values are mean ± SD for replicate independent runs.
** Values that bear different superscript letter in the same raw of each specific beverage are significantly different at $p<0.05$.
A=Blend 1 was prepared using 85% peanut milk and 15% millet thin porridge; B= Blend 2 was prepared using 70% peanut milk and 30 % millet thin porridge; C= Blend 3 was prepared using 55% peanut milk and 45% millet thin porridge.

Table 5. *The energy value of beverages (100 ml) at maximum growth of Bifidobacterium longum BB 536*

Beverages	Peanut milk	Millet thin porridge	Blend A	Blend B	Blend C
Total energy (kcal/100ml)*	**61.19**	**37.06**	**49.93**	**44.76**	**36.18**
Energy from fat	**25.47**	**10.62**	**19.81**	**20.88**	**19.26**
Energy from protein	**13.8**	**7.8**	**11.32**	**10.68**	**9.08**
Energy from carbohydrates	**21.92**	**18.64**	**18.8**	**13.20**	**7.84**

* The energy value was calculated using factors of 4.00 kcal/g for protein, 9.00 kcal/g for fat and 4.00 kcal/g for total carbohydrate. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (2002/2005).