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Quality Attributes of Soy-yoghurt During Storage Period

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Abstract: The utilization of soybean milk in manufacturing yoghurt in Sudan was investigated. Soybean milk was prepared from grinded soybean seeds. Four samples of soy yoghurt product were used, namely sample A) 100% soymilk (sample B) 1:1 soymilk: cow milk), sample C (2:1 soymilk: cow milk) and sample D (1:2 soymilk: cow milk). The prepared soy yoghurt samples were stored at refrigerator temperature (10±2°C) followed by analyses at 0, 5, 10, 15 and 20 days intervals. The chemical compositions of soybean milk used were the total solids (13.15%), protein (7.64%), fat (2.75%), pH-value (6.70) and titratable acidity (0.20%).The type of milk significantly ($p \leq 0.05$) affected the pH-value of the soy yoghurt. Sample A was the highest (4.50), sample D the lowest (3.30) while sample B and sample C were at an intermediate position (3.50 and 3.70 respectively). Storage period significantly ($p \leq 0.05$) affected the pH-value of soy yoghurt, the highest value (4.30) was obtained at the beginning of the storage period, while the lowest value (3.00) at the end. The type of milk significantly ($p \leq 0.05$) affected the titratable acidity of the soy yoghurt. Sample A was the lowest (1.12%), Sample D was the highest (2.50%), while samples B and C were in an intermediate position. Storage period significantly ($p \leq 0.05$) affected the titratable acidity of soy yoghurt. The lowest titratable acidity (1.21%) was obtained at the beginning of storage period and the highest (2.60%) at the end. The type of milk significantly ($p \leq 0.05$) affected the wheying off of the soy yoghurt. Sample A was the highest (2.70 ml), sample D was the lowest (1.70 ml), while samples B and C were at an intermediate position. Storage period significantly ($p \leq 0.05$) affected the wheying off of soy yoghurt. The lowest wheying off (0.00 ml) was obtained at the beginning of storage period and the highest (4.00 ml) at the end. The chemical analyses of soy yoghurt samples at zero time processing, sample A) 100% soymilk (was the highest (31.20%) for total solids and protein content (16.70%),while sample D (1:2 soymilk: cow milk) was the lowest (15.70%) for total solids and protein content) 11.25). Sample B and C were at an intermediate position. Sample A was the lowest (2.20%) for fat content, sample D was the highest (3.25%),while samples Band C occupy an intermediate position. The sensory evaluation significantly ($p \leq 0.05$) affected by The type of milk and storage period revealed that, the best score ($p \leq 0.05$) in appearance (4.38), flavour (4.10), texture (4.22) and overall acceptability (4.28) in sample D(1:2 soymilk: cow milk), the worst was recorded by sample A (Soymilk 100%) for appearance (2.68), flavour (3.48), texture (3.36) and overall acceptability (3.44). The other samples were at an intermediate position. It was found that 10 days storage period at refrigerator temperature (10±2°C) was quite satisfactory to attain good quality soy yoghurt.

Key words: Soy milk, yoghurt, storage, cow milk

INTRODUCTION

Vegetable milk is prepared from food grains such as soya bean, sesame and groundnut. Soybean (*Glycine max*), a plant protein which is cheaper could serve as an alternative to cow milk. Soybean milk is richer in protein than most animal milk. It contains up to 40% protein compared with 1.0% to 5.6% protein content of most animal milk (Burton, 1985). Soymilk is processed from soybean. Intake of fermented soymilk improves the ecosystem in the intestinal tract by increasing the amount of probiotics (Chang *et al.*, 2005). Soybean and its derivates represent an excellent source of high quality protein, with low content of saturated fat and a great amount of dietary fiber and bioactive components like the isoflavones. Soymilk and its fermented products constitute an alternative for lactose intolerant people. In this way, soy yoghurt could be a suitable vehicle for iron fortification, since it has high nutritional value and low-cost. However, calcium content of soymilk is lower that found in cow's milk, being necessary the addition of this mineral to improve its nutritional properties. The objective of this work is to prepare the milk from soybean seeds and to study their effects on quality of Sudanese soy yoghurt during storage period.

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MATERIALS AND METHODS

The seeds were obtained from the local market. The starter culture *Lactobacillus bulgaricus* and *Streptococcus thermophilus* were obtained from Khartoum Dairy Products Company Ltd. Plastic cups (250 ml volume) were purchased from retailers in the local market. Fresh cow milk was obtained from the University of Sudan Dairy Farm (Shambat).

Preparation of soymilk: Soybean milk was prepared by soaking kernels in 0.5% sodium bicarbonate solution for 16-18 h, drained, washed with tap water, grinded, steeped for 4-5 h in tap water (100 g soybean mixed with 100 ml tap water) and filtrated through cheese cloth to obtain the soymilk.

Preparation of soy-yoghurt: Four samples (A, B, C and D) were selected in which soymilk was kept in equal volumes after being filtered from impurities. Sample (A) 100% soymilk, sample (B)1:1 soymilk: cow milk, sample © 2:1 soymilk: cow milk and sample (D) 1:2 soymilk: cow milk. The volumes were pasteurized at 85°C for 10 min and then cooled to 45°C. Starter culture 3% of the milk volume was added in the form of (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*). The milk mixture was placed in 250 ml cups and kept in an incubator at 45°C for 3-6 h. The cups were transferred to refrigerator and stored in a temperature of 10±2°C for 0, 5, 10, 15 and 20 days intervals. The Analyses were carried for physicochemical, rheological and sensory evaluation.

Chemical analyses: The pH-values of samples were determined according to Newlander and Atherton (1964), while the titratable acidity, total solids, protein and fat content were determined according to AOAC (1995).

Rheological properties: Wheying-off was measured by sucking off the water from the surface of the curd and poured in a graduated cylinder.

Sensory evaluation: The sensory evaluation was performed by 10 untrained panelists using procedure according to Ihekoronye and Nogddy (1985).

Statistical analyses: Data was subjected to statistical analyses using Statistical Analysis System program (SAS, 1988).

RESULTS AND DISCUSSION

Soybean milk: The results of chemical properties of soy milk were of total solids (13.15%), pH-value (6.70), titratable acidity (0.20%), protein content (7.64%) and fat content (2.75%).

Tuitemwong *et al.* (1993) found that, the soymilk has desirable characteristics as an ingredient for making soy yoghurt because of its high solid content (Moriguchi *et al.*, 1961). Angeles and Marth (1971) found a titratible acidity of 0.23-0.25% or a pH of 5.7. Wolf, (1978) concluded 60-70% of the total protein in the soybean is stored in the protein bodies. Deshpande *et al.* (2008) found that, the soymilk contains total solids (9.8%), fat (2.6%), protein (5.8%), pH value (6.0) and ash (0.6%). Lee *et al.* (1990) stated the variation in the results to the origin of soybean and to the processing condition.

Chemical properties of soy yoghurt

pH-value: The type of milk was significantly ($p \leq 0.05$) affected pH-values of the soy yoghurt (Table 1). Samples D (1:2 soymilk: cow milk) was the lowest (3.30) and sample A) 100% soymilk (the highest (4.50), while samples B (1:1 soymilk: cow milk) and C (2:1 soymilk: cow milk) were at an intermediate position (3.50 and 3.70) respectively.

Storage period significantly ($p \leq 0.05$) affected the pH-values, where they decreased gradually till the end of storage (Table 2 and Fig. 1). The highest pH-value (4.30) was obtained at the beginning of the storage period, whereas the lowest (3.00) at the end. Sugimoto and Van Buren (1970) and Buono (1988) found that, the pH-value of soy yoghurt to be 5.00. Moriguchi *et al.* (1961) stated high optimum pH-values of soy yoghurt varied form 5.0-6.0.

Table 1: Effect of type of milk on pH-value*, titratable acidity* and wheying off* of soy-yoghurt

	Samples					
Parameters	A	B	C	D	$LSD_{0.05}$	SE±
pH-value	4.50±0.08[a]	3.50±0.04[c]	3.70±0.06[b]	3.30±0.02[d]	0.8297	0.2633
Titratable acidity (% lactic acid)	1.12±0.01[d]	1.70±0.04[b]	1.41±0.03[c]	2.50±0.05[a]	0.1151	0.03651
Wheying-off (ml)	2.70±0.06[a]	2.40±0.04[c]	2.50±0.05[b]	1.70±0.02[d]	0.1819	0.05774

*Means±SD. Values having different superscript letter in rows are significantly different ($p \leq 0.05$). A = Soymilk 100%; B = Soymilk: cow milk 1:1; C = Soymilk: cow milk 2:1; D = Soymilk: cow milk 1:2

Table 2: Effect of storage period on pH-value*, titratable acidity* and wheying off* of soy-yoghurt

	Storage period (days)						
Parameters	0	5	10	15	20	$LSD_{0.05}$	SE±
pH-value	4.30±0.09[a]	3.90±0.08[b]	3.70±0.06[c]	3.30±0.04[d]	3.00±0.02[e]	0.1819	0.05774
Titratable acidity (% lactic acid)	1.21±0.01[e]	1.52±0.02[d]	2.00±0.04[c]	2.34±0.06[b]	2.60±0.08[a]	0.1151	0.03651
Wheying-off (ml)	0.00±0.00[c]	1.80±0.01[b]	2.40±0.03[b]	3.00±0.05[ab]	4.00±0.07[a]	1.156	0.3670

*Means±SD. Values having different superscript letter in rows are significantly different ($p \leq 0.05$)

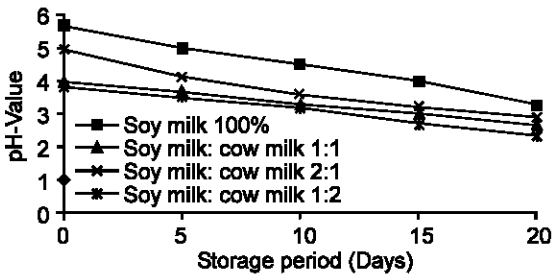

Fig. 1: Effect of storage period on pH-value of soy-yoghurt

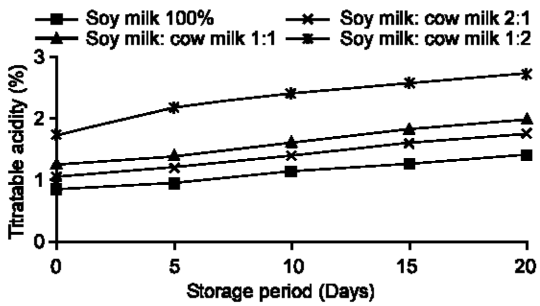

Fig. 2: Effect of storage period on titratable acidity (% lactic acid) of soy-yoghurt

Titratable acidity: The type of milk was significantly ($p \leq 0.05$) affected titratable acidity (Table 1). Sample A (100% soy milk) was the lowest (1.12%), Samples D (1:2 soymilk: cow milk) the highest (2.50), while sample B and C were at an intermediate position (1.70% and 1.41, respectively).

Storage period significantly ($p \leq 0.05$) affected titratable acidity of Sudanese soy yoghurt samples (Table 2 and Fig. 2). Titratable acidity increased gradually till the end of storage. The highest value (2.60%) was obtained at the end, while the lowest (1.21%) at the beginning of the storage.

Methods for the reduction of the flatulent sugars, raffinose and stachyose in soymilk and soybean products have been extensively investigated (Mital *et al.*, 1973; Pinthong *et al.*, 1980a,b; Buono, 1988; Buono *et al.*, 1990a,b). Mital *et al.* (1973) stated the activity of the enzyme alpha-galactosidase (EC 3.2.1.22) in some lactic acid bacteria. The soy yoghurt contains oligosaccharides such as raffinose, stachyose produced during the fermentation process.

Wheying off: The type of milk was significantly ($p \leq 0.05$) affected the wheying off (Table 1). Sample A was the highest (2.70 ml), sample D the lowest (1.70%), while sample B and C were at an intermediate position (2.40 ml and 2.50 ml respectively).

Storage period significantly ($p \leq 0.05$) affected wheying off of Sudanese soy yoghurt samples (Table 2 and Fig. 3). The wheying off increased gradually till the end of storage. The highest value (4.00 ml) was obtained at the end, while the lowest (0.00 ml) at the beginning of the storage period. Lucey *et al.* (2000) found that, stabilizers are commonly used in cultured products to reduce whey separation.

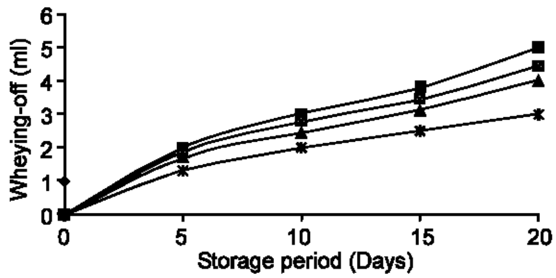

Fig. 3: Effect of storage period on wheying-off of soy-yoghurt

Chemical composition of soy yoghurt samples

Total solids: The type of milk significantly ($p \leq 0.05$) affected the total solids of the soy yoghurt. Sample A) 100% soymilk (recorded the highest content of total solids (31.20%) compared with sample D (1:2 soymilk: cow milk), that gave the lowest (15.70%). Samples B (21.80%) and C (29.40%) showed an intermediate position (Table 3).

Tuitemwong *et al.* (1993) found high total solid content of processed soy yoghurt ranged from 56.02-61.12%. The soymilk has desirable characteristics as an ingredient for making soy yoghurt because of its high solid content. Tamime and Robinson (1999) found the total solids of processed soy yoghurt ranged from 34.2-44.4%.

Protein content: The type of milk was significantly ($p \leq 0.05$) affected the protein content of soy yoghurt (Table 3). Sample A was the highest (16.70%), Sample D the lowest (11.25%), while sample B and Sample C, occupied an intermediate position (13.00% and 14.80%, respectively). Burrington (2000) noticed that, soy proteins are high in the amino acids glycine and arginine.

Fat content: The type of milk was significantly ($p \leq 0.05$) affected fat content of soy yoghurt. Sample D (Soymilk: cow milk 1:2) was the highest (3.25%) whereas sample A (Soymilk 100%) was the lowest (2.20%). While sample B and C showed an intermediate position (3.00% and 3.20, respectively). Tamime and Robinson (1999) reported that, the fat content of processed soy yoghurt varied from 1.2-2.2%. Friedman and Brandon (2001) found that, soy or soy product containing soy protein that meets requirements including low saturated fat and low cholesterol with a minimum of 4.25% of soy protein. Burrington (2000) noticed that, soy proteins are high in the amino acids glycine and arginine, which decrease cholesterol and lower fat levels. Dashiell *et al.* (1990) stated low cholesterol soy milk yoghurt.

Table 3: Chemical composition* (%) of soy-yoghurt

	Samples					
Parameters	A	B	C	D	$LSD_{0.05}$	SE±
Total solids content	31.20±0.09^{a}	21.80±0.02^{c}	29.40±0.06^{b}	15.70±0.04^{d}	0.1819	0.05774
Fat content	2.20±0.01^{c}	3.00±0.01^{b}	3.20±0.46^{ab}	3.25±0.01^{a}	0.3728	0.1183
Protein content	16.70±0.48^{a}	13.00±0.26^{c}	14.80±0.39^{b}	11.25±0.15^{d}	0.1409	0.04472

*Means±SD. Values having different superscript letter in rows are significantly different ($p \leq 0.05$). A = Soymilk 100%; B = Soymilk: cow milk 1:1; C = Soymilk: cow milk 2:1; D = Soymilk: cow milk 1:2

Table 4: Effect of type of milk on quality attributes* of soy-yoghurt

	Samples					
Quality attribute	A	B	C	D	$LSD_{0.05}$	SE±
Appearance	2.68±0.01^{d}	3.37±0.04^{b}	2.86±0.02^{c}	4.38±0.05^{a}	0.3728	0.1183
flavour	3.48±0.02^{c}	3.58±0.05^{b}	3.36±0.04^{bc}	4.10±0.06^{a}	0.0814	0.0258
Texture	3.36±0.01^{c}	3.56±0.03^{b}	3.46±0.02^{bc}	4.22±0.04^{a}	0.0006	0.0002
Overall acceptability	3.44±0.03^{c}	3.88±0.05^{b}	3.68±0.04^{d}	4.28±0.07^{a}	0.0006	0.0002

*Means±SD. Values having different superscript letter in rows are significantly different ($p \leq 0.05$). A = Soymilk 100%; B = Soymilk: cow milk 1:1; C = Soymilk: cow milk 2:1; D = Soymilk: cow milk 1:2

Table 5: Effect of storage period on quality attributes* of soy-yoghurt

	Storage period (days)						
Quality attribute	0	5	10	15	20	$LSD_{0.05}$	SE±
Appearance	3.26±0.01^{d}	3.52±0.03^{c}	3.86±0.05^{a}	3.62±0.04^{b}	2.28±0.02^{e}	0.0006	0.0002
Flavour	3.58±0.03^{e}	4.04±0.05^{c}	4.30±0.06^{a}	4.10±0.05^{b}	3.68±0.02^{d}	0.0006	0.0002
Texture	3.64±0.02^{c}	3.88±0.03^{b}	4.07±0.04^{a}	3.86±0.03^{b}	3.62±0.02^{c}	0.0006	0.0002
Overall acceptability	3.76±0.03^{c}	4.10±0.04^{b}	4.30±0.06^{a}	4.10±0.04^{b}	3.68±0.02^{d}	0.1409	0.0447

*Means±SD. Values having different superscript letter in rows are significantly different ($p \leq 0.05$)

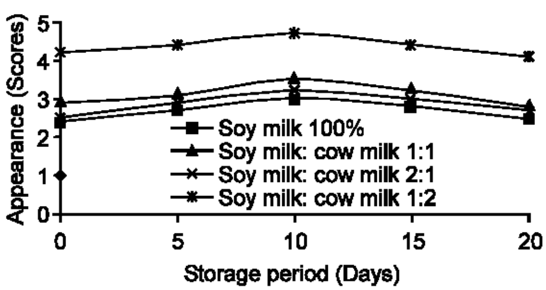

Fig. 4: Effect of storage period on appearance of soy-yoghurt

Organoleptic quality of Sudanese soy yoghurt samples

Appearance: The type of milk was significantly ($p \leq 0.05$) affected the appearance of yoghurt. Table 4 shows the appearance score of Sudanese soy yoghurt. Sample D (soymilk: cow milk 1:2) significantly ($p \leq 0.05$) secured the best appearance (4.38). Sample B and C in an intermediate position (3.37 and 2.86, respectively). The worst (2.68) recorded by sample A (soymilk 100%).

Storage period significantly ($p \leq 0.05$) affected the appearance of the soy yoghurt samples (Table 5 and Fig. 4). The best scores (3.86) were obtained at day 10 and the worst (2.28) at the end of the storage period. Pinthong *et al.* (1980a); Nielsen (1985) reported that, the fermented soybean milk was more acceptable than others and was preferred in terms of colour. Cuenca *et al.* (2005) found that, the soy yoghurt fermented with starter culture improve colour can be fortified with especially natural fruit juices to meet the requirement of consumers.

Flavour: Table 5 illustrated the flavour score of the Sudanese soy yoghurt. Sample D made with (Soymilk: cow milk 1:2) significantly ($p \leq 0.05$) secured the best flavour (4.10), followed by sample B and C. The worst flavour (3.48) was recorded by sample A (Soymilk 100%).

Storage period significantly ($p \leq 0.05$) affected the flavour of the soy yoghurt samples (Fig. 5). The best score (4.30) was obtained at day 10 and the worst (3.58) at the beginning of the storage period.

Lactic acid fermentation reduced beany flavours in soybean products (Pinthong *et al.*, 1980a,b; Buono, 1988; Buono *et al.*, 1990a).

Liu (1997b) found that, fermentation of soymilk offers not only a means of preserving soymilk but also a possibility for modifying or improving flavour. Cuenca *et al.* (2005) mentioned that, the soy yoghurt fermented with starter culture improve taste can be fortified with especially natural fruit juices to meet the requirement of consumers.

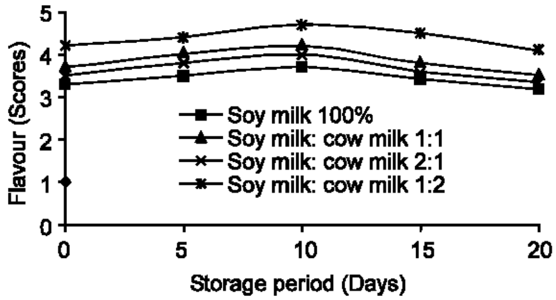

Fig. 5: Effect of storage period on flavour of soy-yoghurt

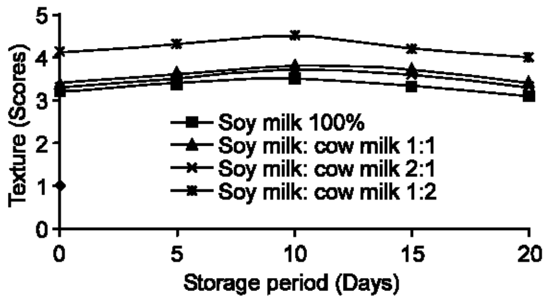

Fig. 6: Effect of storage period on texture of soy-yoghurt

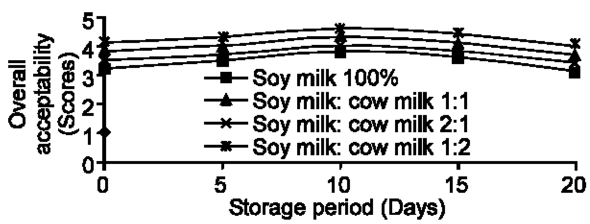

Fig. 7: Effect of storage period on over all acceptability of soy-yoghurt

Texture: The type of soy milk was significantly ($p \leq 0.05$) affected the texture of yoghurt. Sample D significantly secured the best texture (4.22). Samples B and C ranked in an intermediate position (3.56 and 3.46, respectively). The worst texture (3.36) recorded by sample A (Table 5).

Storage period significantly ($p \leq 0.05$) affected the texture of the soy yoghurt samples (Fig. 6). The best scores (4.07) were obtained at day 10 and the worst (3.62) were obtained at the end of the storage.

Liu (1997a) stated that, fermentation of soymilk offers not only a means of preserving soymilk but also a possibility for modifying or improving texture. Lucey *et al.* (2000) found that, stabilizers are commonly used in cultured products to control texture soy yoghurt.

Overall acceptability: The overall acceptability of Sudanese soy yoghurt samples prepared from soybean milk were affected by the type of milk (Table 5). Sample D made with (soymilk:cow milk 1:2) significantly secured the best acceptability (4.28), followed by sample B (3.88) and C (3.68). The worst (3.44) was recorded in sample A made with 100% soymilk.

Storage period significantly ($p \leq 0.05$) affected the overall acceptability of the soy yoghurt samples (Fig. 7). The best score (4.30) was obtained at day 10 and the worst (3.68) at the end of the storage period.

Organoleptic quality of fermented products is directly related to levels of n-pentanal and n-hexanal, the form being produced by *S. thermophilus* and the latter being naturally present in soy milk (Pinthong *et al.*, 1980a). Pinthong *et al.* (1980b) found that, fermented soy milk contained less n-hexanal than the unfermented soymilk. Beany flavours, chalkiness and astringent characteristics have been reported as the major sensory attributes found by sensory evaluation of soy yoghurt samples by trained panels (Tuitemwong *et al.*, 1993).

REFERENCES

Angeles, A.G. and E.H. Marth, 1971. Growth and activity of lactic acid bacteria in soymilk. I. Growth and acid production. J. Milk Food Technol., 34: 30.

AOAC, 1995. Official Methods of Analysis. 14th Edn., Association of official analytical chemists, Washington, DC.

Buono, M.A., 1988. An engineering microbiology and sensory study of yoghurt from soy milk. Ph.D. Dissertation. Kansas State University, Manhattan.

Buono, M.A., L.E. Erickson and D.Y.C. Fung, 1990b. Carbohydrate utilization and growth kinetics in the production of yoghurt from soymilk. Part II: Experimental and parameter estimation results. J. Food Proc. Preserv., 14: 179-204.

Buono, M.A., L.E. Erickson, D.Y. Fung and I. Jeon, 1990a. Carbohydrate utilization and growth kinetics in the production of yoghurt from soymilk. Part I: Experimental methods. J. Food. Proc. Preserv., 14: 135-153.

Burrington, K., 2000. Nutritional and beneficial ingredients. Food Product Desing, pp: 1-12.

Burton, J.W., 1985. Breeding soybean for improved protein quality and quantity. In: Proceeding of the 3rd World Soybean Research Conference, (Shibles R Ed.). West View Press, bowlder, Colorado pp: 136-165.

Chang, I.C., H.F. Shang, T. Lin, T.H. Wang and S.H. Lin, 2005. Effect of fermented soymilk in the intestinal bacteria ecosystem. World J. Gastroenterol., 11: 1225-1227.

Cuenca, M., L. Caicedo, M. Holguin and M. Quicazan, 2005. Fermentaion lactica de una mezcla de bebida de soya leche de vaca utilizando celulas libres inmovilizadas. Memorias Segundo simposio sobre biofabricas. Cited from PDF (2005).

Dashiell, K.E., S.R. Singh, O. Nakayama, H.O. Ogundipe and C.N. Akeem, 1990. Soybean research at IITA. GLIP Research Monograph No. 1Ibadan.

Deshpande, S., P. Bargale and K. Jha, 2008. Suitability of soymilk for development of shrikhand. J. Food Sci. Technol., 45: 284-286.

Friedman, M. and D.L. Brandon, 2001. Nutritional and health benefits of soy proteins. J. Agric. Food Chem., 49: 1069-1086.

Ihekoronye, N.I. and P.O. Nogddy, 1985. Integrated food, Sci. and Tech. for Tropics. Macmillan Publisher.

Lee, S.Y., V.C. Morr and A. Seo, 1990. Comparison of milk based and soy milk yoghurt. J. Food Sci., 55: 532-536.

Liu, K., 1997a. Chemistry and nutritional value of soybean components. In soybeans: Chemistry, technology and utilization. Liu K. Chapman and Hall: New York, pp: 25-113.

Liu, K., 1997b. Soybeans: Chemistry, technology and utilization. International Thompson Publisher.

Lucey, J.A., M. Tamehana, H. Singh and P.A. Munro, 2000. Rheological properties of milk gels formed by a combination of rennet and glucono-lactone. J. Dairy Res., 67: 415-427.

Mital, B.K., R.S. Schallenberger and K.H. Steinkraus, 1973.Alpha-galactosidase activity of lactobacilli. Appl. Microbiol., 26: 783-788.

Moriguchi, S., H. Ishikawa, R. Ueda and M. Hayashida, 1961. Studies on organic acids in soybeans and defatted soybeans. Hokko Kogaku Zasshi, 39: 237-243.

Newlander, J.A. and H.V. Atherton, 1964. The chemistry and testing of dairy products, 3rd Edn., (revised), Olsen-Publishing Co., Milwaukee, Wisconsin.

Nielsen, N.C., 1985. Structure of soy proteins. Ch. II. In new protein foods, vol. 5, seed storage proteins, A.M. Altschul and H.L. Wilcke (Eds.). Academic press, Inc. Orlando, FL.

Pinthong, R., R. Macrae and J. Rothwell, 1980a. The development of a soya-based yoghurt: I. Acid production by lactic acid bacteria. J. Food. Tech., 15: 647-652.

Pinthong, R., R. Macrae and J. Rothwell, 1980b. The development of a soya- based yoghurt. II. Sensory evaluation and analysis of volatiles. J. Food Technol., 15: 653-660.

SAS, 1988. Statistical Analysis System Institute, Inc., Cary, NC.

Sugimoto, H. and J.P. Van Buren, 1970. Removal of oligosaccharides from soy milk by an enzyme from *Aspergillus saitoi*. J. Food Sci., 35: 655-660.

Tamime, A.K. and R.K. Robinson, 1999. Yoghurt Science and Technology. Woodhead publishing Ltd and CRC press LLC. Boca Raton, Florida, pp: 619.

Tuitemwong, P., L.E. Erickson, D.Y. Fung, C.S. Setser and S.K. Perng, 1993. Sensory analysis of soy yoghurt and frozen soy yoghurt produced from rapid hydration hydrothermal cooked soy milk. J. Food Quality, 16: 223-239.

Wolf, W.J., 1978. Purification and properties of the proteins. Ch. 4 in soybeans: chemistry and technology. Vol. 1 protein, revised 2nd printing. A.K. Smith and S.J. Circle. (Eds.), AVI publishing Co., Inc., Westport, CN.