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Evaluation of the rheological properties of yoghurt prepared from dairy milk and soy milk

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ABSTRACT

Rheological properties of foods, such as fermented dairy products, are important in the design of flow processes, quality control, storage and processing and in predicting the texture of foods. The aim of this research was to evaluate of the rheological properties of yoghurt prepared from dairy milk and soy milk. From the results of this research it was observed that the formulations exhibited pseudo-plastic behaviour, since the flow indice (n) in all the samples were less than one (n<1). This indicated that the viscosities of the samples decreased with increasing shear rate. This pattern is referred to as shear thinning where shear stress increased with increase in shear rate. This is expected because an increase in rotational speed increases molecular alignment in the direction of flow, reducing resistance to flow and hence viscosity. In conclusion, incorporation of yoghurt at levels of 50% to 50% of the total sample mix for soy based yoghurt resulted in increased viscosity and decreased specific gravity of the resultant mix.

Keywords:Rheological properties, yoghurt, dairy milk and soy milk.

INTRODUCTION

Yoghurt is a fermented dairy product obtained by lactic acid fermentation of milk by the action of yoghurt starter bacteria [1,2,3]. It is more nutritive than milk due to higher milk solids, protein contents, calcium, phosphorous, and range of vitamins in addition to nutrients developed during fermentation [4,5]. Levels of some vitamins, such as vitamin B1 and pantothenic acid are reduced as they are utilized by the bacterial culture. Flavour and consistency are its main parameters in yoghurt [6]. Consumer acceptance of yoghurts is based on physical attributes like lack of syneresis and perceived viscosity [7], acidity and aroma perceptions and the textural properties [8,9] crucial for the quality and overall sensory performance. Viscous properties are of primary importance with respect to the quality of products [10,11]. Yoghurt has non –Newtonian flow properties with strong time dependence on both the thixotropic and viscoelastic types [12,13]. [14], noticed pseudo plastic behaviour in fermented milks made from dairy milk. Rheology is a science related to the flow of fluids and deformation of matter [15]. Rheological properties of yoghurt during preparation are affected by different sources of milk [6]. Viscosity of yoghurt is affected by total solids, milk composition, homogenization, type of culture, acidity, stabilizer, degree of proteolysis and preheat treatment of milk [7].

Justification for the study

The following are some inherent setbacks that necessitated the study.

i. High cost of dairy milk, which iss the major source of milk for yoghurt production.
ii. High cholesterol content in dairy milk

Considering these outlined limitations in the production and consumption of dairy yoghurt in Nigeria today, there is need to articulate an alternative source, which includes:

(a) Getting raw materials whose cost would be affordable to the small and cottage entrepreneurs.
(b) Considering the health benefit of plant protein

The Objective of research

The main objective of this work was to determine the rheological properties of yoghurt prepared from dairy milk and soymilk.

MATERIALS AND METHODS

Sources of materials

Soy beans, powdered milk, sugar, sodium benzoate, flavouring agent and starter culture were purchased from meat market, Abakaliki, Ebonyi State, Nigeria

SAMPLE PREPARATION

Soy milk production.

To produce soy milk with uniform consistency and reduced particle size, 7.0 kg of dried soy beans grain was weighed and soaked in warm water (45°C) for 24hour. At interval of 8 hour, the warm water was drained off and replaced with a new one to reduce the beanie flavour of the soy beans grain. After soaking the dried soy beans overnight, the beans was de-husked, washed with water and poured into a blender with fresh water, which was blended thoroughly into a paste. Three litres of clean tap water was added and thoroughly mixed to give slurry. The soy bean milk was extracted by transferring the slurry to a clean white sieve cloth where filtration by suction took place. The beans dreg on the filter cloth was dried and used as livestock and poultry feed. The extracted milk was transferred into a pot and pasteurized at 85 ^{0}C for an hour and allowed to cool gradually to a temperature of about 42-45 ^{0}C. The yellowish wad appeared on the surface was scooped off using a clean spoon. The cooled homogenised milk was incubated with the already prepared starter culture. The mixture was stirred properly and kept to stand at a temperature of about 30-35 ^{0}C for 24 hour. After this period the yoghurt is produced. Sugar, flavour and preservatives are seldom added.

The yoghurt production

The yoghurt was prepared according to the procedure described by [3]. The milkwas first filtered using a clean cheese cloth. The milk was warmed to 43-45 0C and thereafter 6.5% sugar and 2.5% skimmed milk powder were added and stirred. The milk was further heated to 85 0C and was held at this temperature for 30 minutes with continuous stirring. After 30 minutes the milk was cooled to 42 0C after which it was inoculated with freeze dried thermophilic yoghurt starter culture and the amount to be used was based on the manufacturer's specifications. The milk was incubated for 4-6 hours after which the milk was refrigerated for 12 hours to stop the fermentation process. The set yoghurt was stirred by first breaking the curd and presented to panellist in white identical cups for sensory quality evaluation and acceptability determination.

The blends

The method described by [5] with slight modifications was adopted. The fresh soy yoghurt will be produced at different ratios, starting from the 100% un- blended milk sources (100 % DM and 100 %SM) respectively (where DM- represents dairy milk and SM- represents soy milk). For the blends, formulation ratios of 1000 ml of soy milk and 1000 ml of dairy milk was measured out for the proportion in which it is to be blended. 10mls of dairy milk was blended to 90 ml of soy milk, (representing 10 % DM and 90 %SM), 20 ml of dairy milk and 80 ml of soy milk (20 %DM and 80 %SM), 30mls of dairy milk and 70mls of soy milk,(30 %DM and 70 %SM), 40mls of dairy milk and 60mls of soy milk(40 %DM and 60 %SM), 50mls of dairy milk and 50mls of soy milk(50 %DM and 50 %SM), 60mls of dairy milk and 40mls of soy milk(60 %DM and 40 %SM),while 70mls of dairy milk and 30mls of soy milk represents (70 %DM and 30 %SM),80mls of dairy milk and 20mls of soy milk(80 %DM and 20 %SM), 90mls of dairy milk and 10mls of soy milk(90 %DM and 10 %SM). These blends was cultured, inoculated, and processed for yoghurt production, and labelled based on the percentage ratio of mixture of the processed milk sources.

S/n	Soy Milk (%)	Dairy Milk (%)
1	100	0
2	0	100
3	90	10
4	80	20
5	70	30
6	60	40
7	50	50
8	40	60
9	30	70
10	20	80
11	10	90

Table1: Ratios of dairy milk / soy milk blends

Determination of viscosity of the samples

The viscosity of the samples was determined using digital display viscometer (model NDJ85), with minor modifications. The temperature of soy yoghurt samples was maintained at room temperature (28 ±2 ^{0}C) using water bath (model: Ambassador). The viscosities of the sample was measured at a constant shear rate (60rpm) using the spindle TL_2. The sample was brought to the level of immersion groove on the spindle shaft. The viscosity value obtained was multiplied with the dial reading values by appropriate factors supplied from the viscometer used.

Refractive Index

The refractive index or the brix content of the sample soy yoghurt was determined using the method described by [8]. The abbes refractive meter was calibrated with distilled water in a light compensator; the sample was smeared on the lower prism of the refractor meter and closed. A light will be passed by the means of the angled minor while the self-elected light will appear in form of a dark background which was fine adjusted by moving the telescope tube until the black shadow appears on the central of the cross line indicator. The reading of the refractive index will then be read off the screen; also the brix index in percentage will be read at specific temperature.

Statistical analysis

The data obtained was analysed using analysis of variance (ANOVA) and means was compared by Duncan's Multiple Range test [5].

RESULTS

Rheological properties of yoghurt made from soy milk and dairy milk blends

Results presented in Figure 1. Shows the apparent viscosity and the shear rate values.

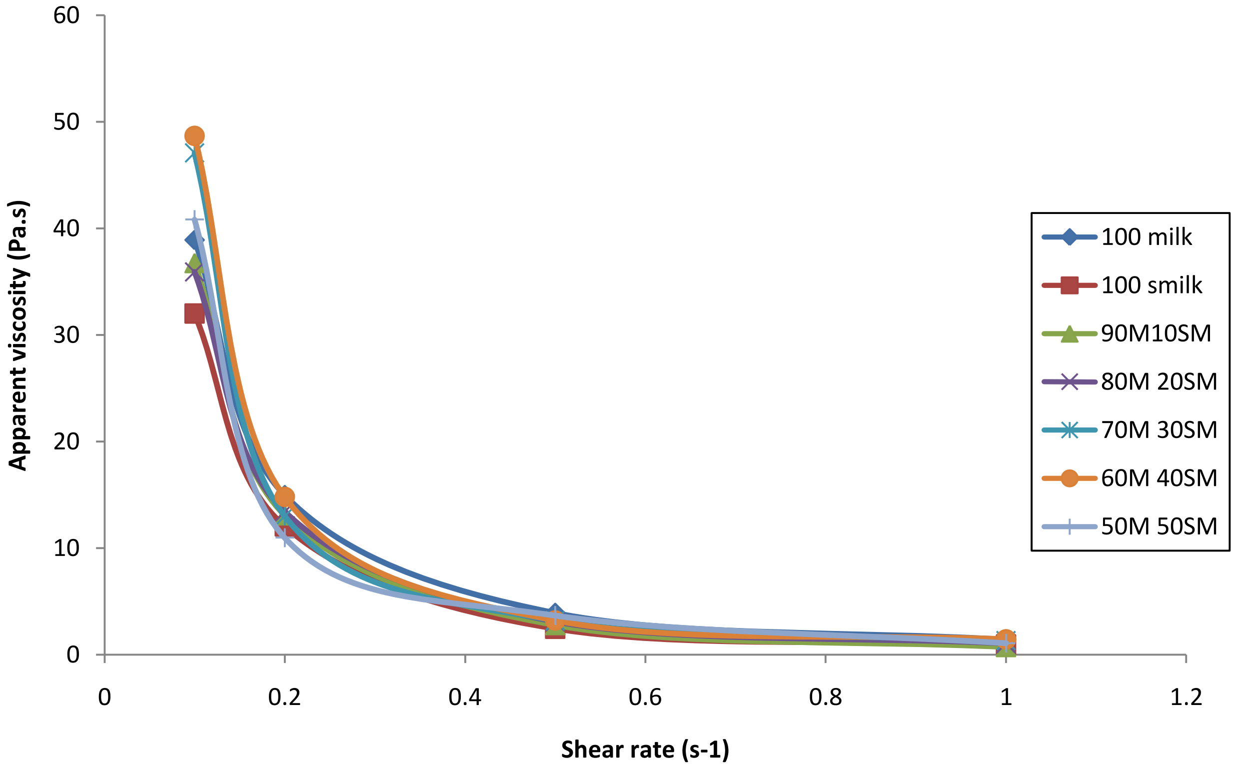

Figure 1: The shear rate and apparent viscosity of the blended samples

Results presented in Figure 2. Shows the shear stress and the shear rate values of the samples

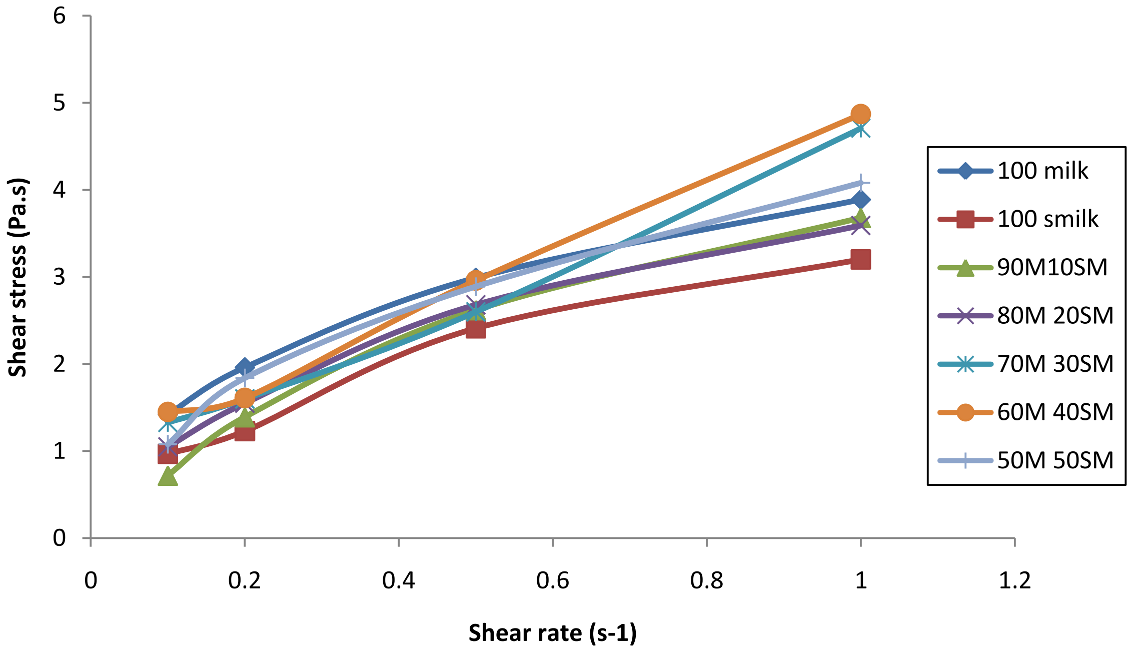

Figure 2: The shear stress versus shear rate of the blended samples.

Consistency coefficient and flow behaviour indices

Presented in Table 2 are the consistency coefficient and flow behaviour indices of soy Yoghurt blends.

Table 2: Consistency Coefficient and flow behavior indices of soy yoghurt blends.

Samples	K(Pa. s)	n	R^2
100SM	0.927	0.548	0.9814
100 DM	1.436	0.441	0.9982
90SM 10DM	0.781	0.707	0.9837
80SM 20DM	1.065	0.543	0.9958
70SM 30DM	1.204	0.546	0.9565
60SM 40DM	1.286	0.545	0.9522
50SM 50DM	1.123	0.524	0.9374

n= flow behavior index, k= consistency coefficient, R^2 = Regression Coefficient

Values of k ranged from 0.781 for 90%SM 10% DM to 1.436 for 100%DM, while regression coefficients vary from 0.9374 for 50%DM 50%SM to 0.9982 for 100%DM. The correlation coefficient of each sample is above 9.5% this implies that there was a high degree of positive relationship between shear stress and shear rate. Also the coefficient determination R^2 was above 92% for each sample. This means that about 92% of the variation in shear stress can be statistically explained by variation in shear rate.

DISCUSSION

Rheological properties

From figures 1 and 2 it was observed that the formulations exhibited pseudo-plastic behaviour, since the flow indice (n) in all the samples were less than one ($n<1$). This indicated that the viscosities of the samples decreased with increasing shear rate. Similar trends were observed by [1,2,3,4] for soymilk and dairy milk blends. This pattern is referred to as shear thinning where shear stress increased with increase in shear rate (Figure 2). This is expected because an increase in rotational speed increases molecular alignment in the direction of flow, reducing resistance to flow and hence viscosity [6]. The consistency indices are presented in Table 2 which shows that they decreased with decreasing soymilk in the yoghurt samples. The flow behaviour index (n) increased when increase in dairy milk content from 10 % to 20 % and then decreased with increase of dairy milk to 30 %, before increasing with increase in dairy milk content to 40 % and finally decreased with increase of dairy milk to 50 % milk content. The lower the value of flow behaviour (n) and away from unity ($n=1$), the more pseudo-plastic the material [8]. The curve obtained in Figure 1 is typical of dispersions exhibiting pseudo plastic flow indicating that the addition of soy milk did not alter the rheological class of the yoghurt dispersion. This phenomenon has been widely reported to be common with hydro colloid solution and food pastes with sensitive structures [8]. The higher consistency coefficient obtained for the blends in the study may be attributed to the incorporation of soy flour and the effect of soy protein plus carbohydrates on water absorption and viscosity of the samples. Similarly, [5] showed that the use of dietary fibres in dairy milk yoghurt formulations significantly increased viscosity and shear thinning behaviour.

CONCLUSION

Incorporation of yoghurt at levels of 50% to 50% of the total sample mix for soy based yoghurt resulted in increased viscosity and decreased specific gravity of the resultant mix. All dairy milk mixes were pseudo plastic (non-Newtonian, time independent fluids with shear thinning behaviour). And the samples did not significantly differ from each other in this respect.

RECOMMENDATION

The fortification of yoghurt with soy solids using stabilizers is however recommended considering the iso flavones and mineral content in soymilk. The discovery of cheaper vitamins in plant protein as alternative to animal protein could solve problem of lactose intolerant individual and increased vitamins demand in developing countries considering their nutritional benefit. The addition of soy solids is advantageous and its uses as vitalized food supplement. The high cost of imported milk and milk production in Nigeria and Africa seen to have made consumers more ready to accept milk produced from plant protein.

REFERENCES

1. Afonso, I. M. and J. M. Maia. 2000. Rheological monitoring of structure development and rebodying of set-style yoghurt. Appl. Rheol. 10:73-79
2. Alvarez, E., Cancela, A. and Maceiras, R.(2005). Rheological behaviour of powdered baby foods. International Journal of food properties, 8: 79-88.
3. Amanze, J.O. (2011).Quality evaluation of yoghurt from cow milk, soy milk and cow/soymilk. Retrieved on 18th February, 2013 from http://www.transcampus .org, chapter 7.
4. Ariahu, C.C.,Risikat, B. and Tiamiyu O.I.(2001).Influence of soy flour and temperature on tilapia fish homogenate. African journal environmental study.2:138-141.
5. Augustin, M. A., Cheng, L., Glagovskaia 0., Clarke P. T., and Lawrence, A. (2003). Use of blends of skim milk and sweet whey protein concentrates in reconstituted yogurt. *Australian Journal of Dairy Technology,* 58: 30-35.
6. Belitz, H.D., Grosch, W.,Schieberle, P. (2009). Food Chemistry, 4th revised and extended edition, springer-verlage, Heidelberg, Germany 4: 1114.
7. Fiszman, S. M., and Salvador, A. (1999). Effect of gelatine on the texture of yoghurt and of acid heat-induced milk gels. *Food Research and Technology, Food production and patisserie* 1.(2008).Frontline Institute of Hotel Management Studies.*208(2):100-105.*
8. Guinee, T. P., Mullins, C. G., Reville, W. J., and Cotter, M. P. (1995). Physical properties of stirred curd sweetened yoghurts stabilized with different dairyingredients. *MilchwissenschaJt,50: 196-200.*
9. Guirguis, N., Versteeg, K., and Hickey, M. W. (1987). The manufacturing of yoghurt using reverse osmosis concentrated skim milk. *Australian Journal of Dairy Technology, 42:*7-10.39
10. Jaros D., Haque A., Kneifel W.,and Rohm H., 2002. Influence of starter culture on the relationship between dry matter content and physical properties of stirred yoghurt. Milchwissenschaft 57, 8: 447-472.
11. Jaros, D., Rohm, H., Haque, A., Bonaparte, C., and Kneifel, W. (2002). Influence of the starter culture on the relationship between dry matter content and physical properties of set-style yogurt. *Milchwissenschaft,* 57: 325-328
12. Katz, F. (2001). Active cultures add function to yogurt and other foods. *Food Technology, 55(3):*46-49.
13. Kazanes,N. and Fields, M.L.(1981). Nutritional improvement of sorghum by ferment toilJ.Food science 49:819-821(2009).
14. Keogh, M. K., and O'Kennedy, B. T. (1998). Rheology of stirred yogurt as affected by added milk fat, protein, and hydrocolloids. *Journal ofF ood Science,* 63: 1:108-113.
15. Kuehl, R. O. (1994).*Statistical principles of research design and analysis.* Belmont, CA:Duxbury Press.