Effect of Addition of Malted Finger Millet Flour on Physical Properties of Yoghurt

NMNK Narayana*
Department of Animal Science, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka

Abstract
The effect of addition of malted finger millet flour (MFMF) on physical properties of stirred yoghurt was investigated. Stirred yogurts were prepared using commercial pasteurized and homogenized 3.25% fat milk by incorporating MFMF at the rate of 0% (Control), 1% (T1), 2% (T2), 3% (T3) and 4% (T4) levels after the heat treatment of the yoghurt mix at 85°C for 30 min followed by cooling to 60°C. Incubation of yoghurt mix was carried out at 42°C after inoculation of the mix by 2% (w/w) commercial yoghurt culture containing *Streptococcus thermophilus* and *Lactobacillus delbruekii* ssp. *bulgaricus* (1:1) until pH decreased to 4.6. Yoghurts were tested for susceptibility to whey syneresis, water holding capacity (WHC), viscosity and instrumental colour. Significant ($p<0.05$) increase of whey syneresis from 17.1±0.4 to 28.5±0.3%, significant ($p<0.05$) decrease of WHC from 74.9±0.4 to 62.4±0.7% and viscosity from 1.51±0.01 to 1.01±0.02 Pa. s were observed with increasing MFMF in the yoghurt from 0 to 4%. Addition of MFMF up to 4% did not significantly ($p>0.05$) change the L* (lightness) and a* (greenness) values of the yoghurt. However, b* (yellowness) value decreased significantly ($p<0.05$) with increasing MFMF. The results of the study revealed that the incorporation of increasing levels of MFMF decreased the consistency and physical stability of yoghurt, making it less acceptable to the consumers.

Keywords: Colour, Finger millet, Syneresis, Viscosity, Water holding capacity
****Corresponding author:*** nayananarayana1970@gmail.com

Introduction

Finger millet (*Eleusine coracana* L) is a small seeded coarse cereal grain which is widely grown in Asia and Africa. It is a drought tolerant cereal crop and has a great potential to be used in various food applications. On the contrary to maize, finger millet is solely utilized for human consumption, gaining popularity as a relief food for diabetics. According to Gopalan *et al.* (2004), finger millet is rich in protein, iron, calcium, phosphorus, fiber and vitamins. The calcium content of finger millet is highest among the cereals, and iodine content is highest among all the food grains. Further, it has best quality proteins and health promoting phytochemicals. Therefore, it has received attention for potential use in functional food applications. In developing countries, the commercial processing of these locally grown grains into value-added food and beverage products is an important driver for economic development.

Finger millet is primarily processed in many ways for use in various food applications and germination/sprouting is one of such processes. In the germination process of finger millet, both starch and protein are partially degraded leading to better digestibility apart from giving overall improvement of the flavor profile. Further, it is reported that germination of finger millet has a pronounced effect on reducing anti nutrients (Desai *et al.*, 2010).

Yoghurt is one of the most popular fermented dairy products and is produced by fermentation of milk with thermophilic homofermentative lactic acid bacteria namely *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*. Quality of yoghurt can be further enhanced by adding various health promoting and nutritious compounds/ingredients. Physical properties such as whey syneresis, WHC and viscosity are important parameters that determine the textural quality, physical stability and consumer acceptability of yoghurt. Further, colour is an important physical property of yoghurt that affects consumer demand and acceptability. These properties will be affected by the addition of other compounds/ingredients which are used for the enhancement of nutritional as well as functional properties of a food product. Therefore, the current study aimed to investigate the effect of addition of sprouted finger millet flour on the physical properties of MFMF incorporated yoghurt.

Materials and methods

Finger millet grains (500 g) were cleaned and soaked in 2 L potable water overnight at room temperature (26±2°C). Excess water was drained off and kept for sprouting for 48 h. Grains were dried at 60°C for 72 h in a laboratory oven and were ground in to a fine powder using a home mixer grinder. Powder was sieved through a 0.5 mm sieve, packed in polyethylene bags and stored at -18±1°C until used.

Commercial pasteurized and homogenized (3.25% fat) milk was mixed with white commercial sugar at the rate of 6% (w/w) and heat treated at 85°C for 30 min. Gelatin {0.5% (w/w)} was mixed in heated milk-sugar mixture. The mixture was cooled to 60±1°C, divided in to five equal batches of 2 L and put in to glass beakers. One batch with no added finger millet was taken as the control (C). The other 4 batches were added with calculated amount of finger millet flour (w/w) at the rate of 1% (T1), 2% (T2), 3% (T3) and 4% (T4) and mixed well. Each batch was cooled to 42°C, inoculated with 2% (w/w) yoghurt culture (Chr. Hansen), incubated at 42°C in a laboratory incubator until pH decreased to 4.6. Yoghurt was then cooled to 4±1°C, coagulum was broken by stirring and put in to retail cups of 80 ml and refrigerated (4±1°C) overnight before testing.

The pH of the samples was determined using a digital pH meter (Adwa AD 131). Water Holding Capacity of MFMF incorporated yoghurt was calculated according to the method given by Remeuf *et al.* (2003). Whey syneresis (%) was determined by a centrifugation method. The surface colour (at 10±1°C) was measured with a colour reader, Konica Minolta, Model CR 10 (Konica Minolta, Japan) using the L*a*b* CIELAB system. Samples were tampered to 10°C and the viscosity was measured with a Brookfield digital rotational viscometer (Model LV DV-E, Brookfield Engineering Laboratories Inc., Stoughton, MA) using spindle 63 at 20 rpm. Results were analyzed using SPSS statistical software package (version 20).

Results and discussion

Table 1 shows the effect of addition of MFMF from 0 to 4% on physical parameters such as whey syneresis, WHC, viscosity and instrumental colour of yoghurt. Incubation of yoghurt was stopped when the final pH reached 4.6±0.1 in all the treatments.

Whey syneresis is an undesirable property of yoghurt and related products. Even though, the whey syneresis of the control yoghurt was found to be 17.1±0.04% which was the lowest among the treatments, 2% MFMF added yoghurt was most preferred by the sensory panel (data not shown). Addition of MFMF up to 4% significantly ($p<0.05$) increased the whey syneresis at a decreasing rate (Table 1). Three dimensional protein gel matrix of yoghurt helps to immobilize the water in it. However, the addition of other ingredients such as MFMF disturbs this gel matrix and reduces the ability to hold water and release as whey. Highest whey syneresis % in T4 treatment where 4% MFMF added may be because of the more porous and loose gel structure of the curd due to more MFMF, compared to the other samples which had lesser amounts of MFMF. Finger millet in the native form as well as in the malted form is a good source of dietary fiber. Further, researchers showed that, addition of fiber from different sources such as date, orange etc. decreased the whey syneresis of yoghurt (Hashim *et al.*, 2009; Garcia-Perez *et al.*, 2005). However, in this study MFMF increased the whey syneresis compared to the control yoghurt. In the current experiment, MFMF was added and not the fiber in its pure form.

WHC is an important physical parameter of yoghurt and yoghurt like products. It was observed that the WHC decreased significantly ($p<0.05$) with increasing MFMF% in the yoghurt. Control yoghurt with no added MFMF showed the highest WHC of 74.9±0.4%. WHC decreased by 12.5% with the addition of 4% MFMF to stirred yoghurt. It was reported that the germination of FM leads to reduced WHC of

Table 1: Physical parameters of yoghurt as affected by addition of MFMF

Trt	WS (%)	WHC (%)	Viscosity (Pa. s)	Colour		
				L*	a*	b*
C	17.1 ± 0.4^{a}	74.9 ± 0.4^{d}	1.51 ± 0.01^{c}	35.9 ± 1.2^{a}	-10.7 ± 2.0^{a}	14.7 ± 1.5^{b}
T1	20.0 ± 0.5^{b}	67.8 ± 0.4^{c}	1.46 ± 0.05^{c}	35.8 ± 0.5^{a}	-11.1 ± 0.4^{a}	13.1 ± 0.2^{ab}
T2	25.2 ± 0.7^{c}	65.6 ± 0.5^{b}	1.38 ± 0.02^{bc}	35.8 ± 0.9^{a}	-10.9 ± 0.2^{a}	12.9 ± 0.3^{ab}
T3	27.2 ± 0.7^{d}	64.3 ± 0.6^{b}	1.27 ± 0.10^{b}	34.3 ± 0.6^{a}	-10.5 ± 0.2^{a}	12.6 ± 0.2^{a}
T4	28.5 ± 0.3^{d}	62.4 ± 0.7^{a}	1.01 ± 0.02^{a}	33.6 ± 0.8^{a}	-10.3 ± 0.3^{a}	12.4 ± 0.1^{a}

Values are mean ± SD; *n*=3

^{a,b,c,d} Means with different superscripts in each column differ significantly ($p<0.05$)

Trt= Treatment; C=control; T1=1% MFMF added yoghurt; T2=2% MFMF added yoghurt; T3=3% MFMF added yoghurt; T4= 4% MFMF added yoghurt

WS= whey syneresis; WHC=water holding capacity; L*=the degree of lightness; a*=indicator of green (-) and red (+); b*=indicator of blue (-) and yellow (+)

FMF. This is because of the partial hydrolyzation of the starch of FM by the enzyme amylase in to lower molecular weight carbohydrates such as oligo- and disaccharides which are having low WHC. Another reason for the decreased WHC in yoghurt might be attributed to the fact that the disturbances of the protein gel network by the increased MFMF%.

Viscosity was observed to be highest in control yoghurt and decreased significantly ($p<0.05$) at an increasing rate (Table 1) with the increase of the MFMF in the yoghurt. Decrease of viscosity with the increased addition of MFMF might be related to the decreased WHC and increased syneresis in yoghurts due to the loosening of the protein gel matrix. Eissa *et al.* (2011) reported that the viscosity of Sudaneese yoghurt; zabadi decreased with the increase of syneresis.

Color plays an important role in food choice and acceptance by the consumers. As expected the highest L* (lightness) value was observed in the control yoghurt. The L* values of the MFMF incorporated yoghurt decreased by 6.4% from 35.9±1.2 to 33.6±0.8 with the increase of MFMF from 0 to 4% (Table 01). However, the change was not significantly ($p>0.05$) different.

Although the MFMF had a dark colour, since the levels added was less, it was not affect the colour of the stirred yoghurt significantly. The* values of the MFMF incorporated yoghurt was observed to be not affected (Table 01) by the increasing levels of MFMF from 0 to 4%. As mentioned earlier, this may also be due to the less amount of MFMF used in the production of yoghurt. Control yoghurt was more yellow in appearance and it had the highest b* value. The b* value decreased significantly with increasing MFMF level in the yoghurt (Table 01) as expected due to the reduction of yellowish colour in milk by the colour of the added MFMF.

Conclusion

Malted finger millet flour can be used for the development of cereal-based functional dairy product with potential benefits and sufficient acceptability. However, increased level of addition of MFMF should properly be controlled since it leads to decreased physical stability and consistency of MFMF incorporated yoghurt.

Acknowledgement

Financial support in the form of a research grant provided by the Faculty of Agriculture, University of Ruhuna is gratefully acknowledged.

References

Desai AD, Kulkarni SS, Sahoo AK, Ranveer RC and Dandge PB 2010 Effect of Supplementation of Malted Ragi Flour on the Nutritional and Sensorial Quality Characteristics of Cake. Adv J Food Sci Technol 2: 67-71.

Eissa EA, Babikerand EE, and Yagoub AA 2011 Physicochemical, microbiological and sensory properties of Sudanese yoghurt (zabadi) made from goat's milk. *Animal Production Science*, 51: 53-59.

Garcia-Perez FJY, Lario J, Fernandez-Lopez E, Sayas JA, Perez-Alvarez and Sendra E 2005 Effect of orange fiber addition on yogurt color during fermentation and cold storage. Color Res. Appl. 30:457–463.

Gopalan C, Ramasastri BV and Balasubramanian SC 2004 Nutritive value of Indian Foods. National Institute of Nutrition (NIN). Indian Council of Medical Research, Hyderabad. pp 59-67.

Hashim B, Khalil H and afifi HS 2009 Quality characteristics and consumer acceptance of yogurt fortified with date fiber J Dairy Sci. 92: 5403–5407

Remeuf F, Mohammed S, Sodini I and Tissier JP 2003 Preliminary observations on the effects of milk fortification and heating on microstructure and physical properties of stirred yoghurt. Int Dairy J 13: 773–782.