Production and Evaluation of Set type Yogurt Incorporated with Water melon (*Citrallus lanatus*)

S.T.S.K. Warakaulle*, W.A.D.V. Weerathilake* and N.R. Abeynayake**

*Department of Livestock and Avian Sciences, Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka, Makandura, Gonawila 60170, Sri Lanka.

**Department of Agribusiness Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila 60170, Sri Lanka.

Abstract- Yogurt is an increasingly popular cultured dairy product in most of the countries. Popularity of yogurt has increased due to its perceived health benefits. Health-promoting attributes of yogurt containing live and active cultures are well documented. Yogurt is easily digested, has high nutritional value, and is a rich source of carbohydrates, protein, fat, vitamin, calcium, and phosphorus. Main objectives of this research were to find out the ability of producing yogurt incorporated with Water melon and to evaluate the consumer preference for yogurt incorporated with Water melon. Prepared yogurts were analyzed for moisture, ash, total solid, fat, and vitamin C content. Titrable acidity, pH, and microbial quality (Total plate count, Coliform and yeast/mold) have been investigated on 1st, 7th, 14th and 21st days of refrigerated storage. The addition of Water melon juice into the yogurt showed an increase in vitamin C content when compared to the plain yogurt. In addition, decreased levels in the fat, total solids, and titratable acidity were observed comparatively to the plain yogurt. Coliform and yeast/moulds count was less than 10cfu/g in both the control and the experimental yogurt. The addition of 25% Water melon juice into milk in order to produce yogurt, improved the yogurt in terms of color, appearance, odor and overall acceptability of yogurt.

Index Terms- Yogurt, Fruit yogurt, Water melon, Milk, Vitamin C

I. INTRODUCTION

Yogurt can be defined as a fermented dairy product manufactured from fermentation of milk [1]. It is a semi solid fermented product made from heat-treated and standardized milk mixed by the activity of a symbiotic blend of *Streptococcus thermophilus* and *Lactobacillus delbruckii* subsp. *bulgaricus* [2]. According to the Code of Federal Regulations of the Food and Drug Administration (1996c) (FDA) yogurt can defined as the "food produced by culturing one or more of the optional dairy ingredients (cream, milk, partially skimmed milk, and skim milk) with a characterizing bacteria culture that contains the lactic acid-producing bacteria, *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*" [3]. On the other hand, Codex Alimentarius (2003) defines yogurt as a milk produced with. *Streptococcus thermophilus* in conjugation with any Lactobacillus species [2]. Milk fermentation with Lactic Acid Bacteria (LAB) also results in products with distinctive tastes and aromas [1]. Milk of various mammals is used for yogurt making in various parts of the world. However, most of the industrialized production of yogurt uses cow's milk [4]. Since yogurt is a safer product with a unique flavor which has a higher consumer preference, consideration is being given by nutritionists to incorporate inexpensive source of nutrients to make it an almost complete food [5]. Yogurt has some curative characters also. It has been reported that yogurt can lower the blood cholesterol level [6] and helps to control some intestinal disorders like constipation, dysentery etc., [7]. Yogurt is one of the fastest growing cultured dairy products throughout the world [6]. Yogurt and related products continue to increase in popularity in many countries around the world. Consumers, especially children are demanding novel yogurt formulations more than traditional plain yogurt. Few of the novel yogurt formulations are non-fat yogurt, whipped yogurt, yogurt smoothies, organic yogurt and minimally processed fruit yogurt [8].

An increasing demand can be seen for fruit yogurts. Introduction of various fruit-flavored yogurts has significantly contributed to the consumption of yogurt among all ages [9]. There could be many reasons behind this. Incorporation of fruits endorses the healthy image of yogurt. Bardale (1986), reported that the addition of fruit preparations, fruit flavors, fruit purees, and flavor extracts enhances versatility of taste, color, and texture for the consumer [10]. However fruit-flavored yogurts require an appropriate balance of sweetness, sourness and therefore sufficient flavor intensity should be involved in the flavored yogurt to mask the plain yogurt base [11]. There have been many attempts to produce a range of fruit yogurts in Sri Lanka, recently. However, use of Water melon to produce of fruit yogurt has not yet been done so far. Finding the plausibility of producing a yogurt incorporated with Water melon is important since Water melon is a very popular and abundant tropical fruit. Therefore, the aim of this study was to formulate a Water melon incorporated yogurt with higher consumer acceptability. Another objective of this study was to evaluate the effect of Water melon additive on physical, chemical, sensory, and microbiological properties of the yogurt.

II. MATERIALS AND METHODS

Yogurt preparation

Research was conducted in the Laboratories of the Department of Livestock and Avian Sciences and the Department of Food Science and Technology, Wayamba University of Sri Lanka. Full fat cow milk was obtained from the milk collecting center at Makandura, Gonawila, Sri Lanka. Water melon, sugar, and starter culture were purchased from the local market.

Collected Water melon (***Citrullus lanatus***) fruits were washed with clean water and peeled manually. Then the seeds were removed and the Water melon pieces were blended. Cleaned muslin cloth (washed with hot water) was used for filtration of juice. Filtrate was heated at 95˚C for 2 minutes. Cow milk was cream separated using the cream separator to obtain milk with 2.5% fat level. Milk was pasteurized and heated to 85˚C for 40 minutes. Sugar (8.78%) and gelatin (0.6%) were added to milk and mixed well. Heated milk was divided into four equal portions; one portion for control and the other three portions for the experiment. Water melon juice was added to the experimental milk samples at 20%, 25%, and 30% levels. Commercial yogurt starter culture (0.2 g/1L) containing 1:1 ratio of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* was inoculated to the mixture. Prepared mixtures were incubated at 45˚C for 3.5 hours and stored at 4˚C after incubation.

Sensory evaluation

Two sensory evaluations were conducted using 50 untrained panelists drawn from the Wayamba University of Sri Lanka. First sensory evaluation was done to select the best inclusion rate of Water melon incorporated yogurt among the three coded samples (20%, 25%, and 30%). Second sensory evaluation was done to evaluate the consumer preference for Water melon yogurt which was selected from the first sensory evaluation. Panelists were instructed to indicate their preference for the samples. Five-point hedonic scale was used, in which 5 as the highest score and 1 as the lowest for each characteristics namely color, appearance, texture, odor, and overall acceptability.

Proximate analysis

Yogurt samples were analyzed for moisture and fat content using sand pan technique and Gerber method [12, 13]. Whereas the ash content and total solids contents were determined according to the A.O.A.C Protocols [14].

Chemical analysis

Standard pH meter (Eutech instrument, model 510, Malaysia) was used for the determination of pH. Total titratable acidity was determined by titration with 0.1N NaOH and Vitamin C content was determined according to the A.O.A.C Protocols [14].

Microbiological analysis

Prepared yogurt samples were analyzed for total bacterial count, total coliform count, and yeast and mold count after 1, 7, 14, and 21 days of fermentation. Peptone water was used for the serial dilution. One gram (1g) of yogurt sample was taken into a culture tube and dissolved with 9 mL of peptone water. Plate count agar was used as the culture media for the determination of total plate count and incubated at 36^{o}C for 48 hours. Colony counter was used for the enumeration of total plate count. Culture tubes with MacConkey Broth was used as the medium for the determination of Coliform, and incubated at 37^{o}C for 48 hours. Presence of air bubbles in the Durham tubes or any color change indicated the positive results of coliform. Yeast and mold count was determined by inoculating the sample on potato dextrose agar and incubated at 25^{o}C for 5 days.

Statistical Analysis

Data obtained for chemical and proximate analysis were analyzed by t-test using SAS 9.2 version. Data obtained for sensory evaluation were analyzed using Chi-square in SAS 9.2 version and Kruskal-Wallis test in MINITAB 15. All the significances were determined at $\alpha = 0.05$.

III. RESULTS & DISCUSSION

Sensory evaluation

Results of the first sensory evaluation shown that the most preferred Water melon juice added yogurt was the one with 25% concentration of Water melon juice having significance difference ($P<0.05$) compared to 20% and 30%. Results from the sensory tests for the color, appearance, texture, odor, and overall acceptability of yogurts are shown in Table 1. Panelists were able to distinguish a significant difference ($P<0.05$) in all attributes among the two yogurt samples. Water melon juice was incorporated with yogurt with the intension of enhancing the color. It was proved by gaining a higher score for the color of Water melon yogurt (4.20) than the plain yogurt (4.12). Analyzed results for odor showed higher score for Water melon yogurt indicating that through the incorporation of Water melon juice, the odor has increased. Average overall acceptability scores ranged from 4.06 to 4.20 among the two yogurt samples. Moreover, results showed that overall acceptability of Water melon yogurt was significantly different ($P<0.05$). However, consumer preference for the texture of Water melon yogurt was lower than the plain yogurt. Reduction of scores for the texture was observed in Water melon yogurt (4.16) than the plain yogurt (4.26) (Table 1).

Proximate analysis

Water melon yogurt showed significant difference ($P<0.05$) against plain yogurt in total solid content (Table 2). Mean mass fraction of total solid in Water melon yogurt was 17.53 ± 0.32, and this value is similar to that found in yogurts with added raspberry [15]. There was a significant difference in vitamin C content between the Water melon and the plain yogurt ($P<0.05$). Water melon yogurt showed significantly higher vitamin C content (16.46 ± 0.7506 mg/100 g) than the plain yogurt (3.03 ± 0.07 mg/100 g) respectively (Table 2). Mbaeyi and Anyanwu

(2010) also have found that, increased vitamin C content with the increasing concentration of solar dried bush mango pulp with yogurt [16].

Table 1. Sensory attributes of plain yogurt and Water melon juice incorporated yogurt samples.

Criteria	Plain cow milk yogurt	Water melon yogurt
Color	4.12 ± 0.629[a]	4.20 ± 0.689[b]
Appearance	4.12 ± 0.629[a]	4.20 ± 0.689[b]
Texture	4.26 ± 0.755[a]	4.16 ± 0.664[b]
Odor	4.06 ± 0.913[a]	4.40 ± 0.586[a]
Overall acceptability	4.06 ± 0.752[a]	4.20 ± 0.586[a]

Note: Mean values in the same row with different letters are significantly different (P<0.05), n=50

Table 2. Physicochemical characteristics of plain and Water melon incorporated cow milk yogurt.

Composition	Plain cow milk yogurt	Water melon yogurt
Moisture (%)	79.37 ± 0.11[a]	79.35 ± 0.11[a]
Fat (%)	2.43 ± 0.05[a]	2.46 ± 0.05[a]
Ash (%)	0.72 ± 0.01[a]	0.73 ± 0.01[a]
Total solid (%)	17.53 ± 0.32[a]	19.71 ± 0.22[a]
Vitamin C mg/100g	3.03 ± 0.07 [a]	16.46 ± 0.75[b]

Note: Mean values in the same row with different letters are significantly different (P<0.05), n=3

Chemical analysis

Results of the changes in pH during the storage period of two yogurt samples were illustrated in the Figure 1. Significant difference in pH change was observed throughout the storage period at 4°C (P<0.05). Reduction of pH may be due to the action of microbial population in the yogurt. Moon *et al.*, (1993) also have reported that there was a decrease in pH during the storage of gel type yogurt [17]. Bonczar *et al.*, (2002) stated that this can be explained by further metabolic activities of starter cultures during storage [18]. Titrable acidity (TA) of both yogurts increased gradually during the storage at 4°C for 3 weeks (Figure 2). But TA of Water melon incorporated yogurt showed lower values compared to the control. TA of the two yogurt samples were significantly different (P<0.05) at the first day and similar changes were observed for 7, 14, and 21 days of storage. Kucukoner and Tarakci (2004) also found that the plain yogurt had higher mean value of titrable acidity [19]. This phenomenon might be due to the acid production in the experimental yogurt during storage caused by the fermentation [20].

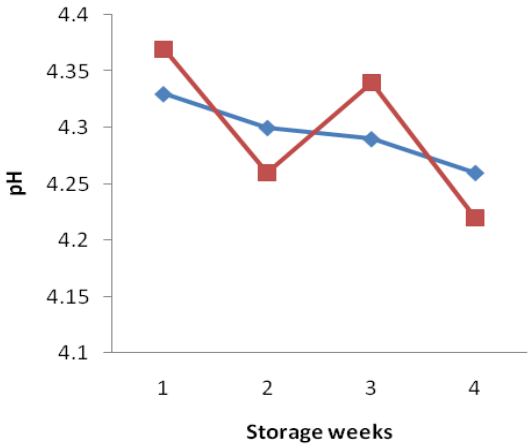

Figure 01. Changes of pH of control (◇) yogurt and Water melon incorporated yogurt (□) during storage.

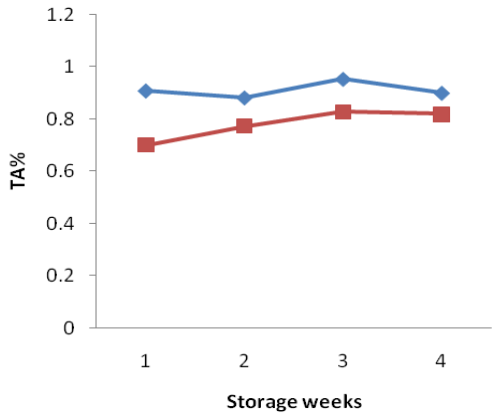

Figure 02. Changes of TA of control (◇) yogurt and Water melon incorporated yogurt (□) during storage.

Microbiological evaluation

Data on the total microbial count in control and Water melon incorporated yogurt samples showed in the Table 3 and was not significantly different (P>0.05) during 1, 7, and 14 days of storage, whereas the means for total bacterial count were significantly different (P<0.05) during 21 days. Peak total microbial count was observed at 14 days of storage in control ($53.00\times10^5 \pm 1.00\times10^5$) and Water melon incorporated yogurt ($51.00\times10^5 \pm 1.00\times10^5$). Total microbial count showed a reduction after 21 days of storage in control ($7.1\times10^5 \pm 0.10\times10^5$) and Water melon yogurt ($6.4\times10^5 \pm 0.34\times10^5$). This may be due to the depletion of nutrients and death of some survivors of the products. Mbaeyi and Anyanwu (2010) also observed that drastic reduction of total viable count of the yogurt samples formulated with solar-dried bush mango pulp [16]. Coliform were absent during the 21 days of storage life whilst 1-2 yeast and mold colonies were observed during the latter part of the storage period.

Table 3. Results for the microbial count of plain and Water melon incorporated yogurt.

	Plain cow milk yogurt			**Water melon yogurt**		
Day	TPC($x10^5$) CFU/g	Coliform	Yeast & Mold	TPC($x10^5$) CFU/g	Coliform	Yeast & mold
1	3.4 ± 0.17	Nil	Nil	3.3 ± 0.10	Nil	Nil
7	6.3 ± 0.30	Nil	Nil	6.2 ± 0.20	Nil	Nil
14	53 ± 1.00	Nil	Nil	51 ± 1.00	Nil	Nil
21	7.1 ± 0.10	Nil	Nil	6.4 ± 0.34	Nil	Nil

IV. CONCLUSION

Based on the results, it can be concluded that twenty five per cent (25%) incorporation rate of Water melon juice into the yogurt mix may enhance consumer appeal of fruit yogurt than that of the 20% and 30% incorporation rates. Moreover, incorporation of Water melon juice could increase Vitamin C content in the fruit yogurt significantly than that of the plain yogurt. Further, addition of Water melon did not change the titrable acidity, pH, and microbial count significantly compared to plain yogurt. Therefore, incorporation of Water melon juice can be suggested as a promising method to enhance the consumer preference towards yogurts while remaining the chemical and microbial qualities of plain yoghurt.

ACKNOWLEDGMENT

Dr. Terence Madujith, Department of Food Science, Faculty of Agriculture, University of Peradeniya, Mr. K.H.M.I. Karunarathne, ICT center, Wayamba University of Sri Lanka, Mr. D.M.D. Rasika, Scientific Officer, National Science Foundation and Laboratory staff of Livestock and Avian Sciences and Food Science and Technology of Wayamba University are gratefully acknowledged for the financial and technical support.

REFERENCES

[1] Chandan, R.C., and Kilara, A. 2011. Dairy Ingredients for Food Processing. Iowa: Blackwell Publishers.

[2] Chandan, R.C., Kilara, A and Shah, N.P. 2008 (Eds). Dairy Processing and Quality Assurance. Iowa: Wiley Blackwell Publishers.

[3] FDA. 1996c. Yogurt. 21 CFR 131.200, Code of Federal Regulations. U.S. Dept. of Health and Human Services, Washington, DC.

[4] Hui, Y.H. 1992. Dairy Science and Technology Handbook. New York: John wiley & sons publishers.

[5] Boghra, V.R. and Mathur, O.N. 2000. Physico-chemical status of major milk constituents and mineral at various stages of shrikhand preparation. J Food Sci Technol. 37:111-115.

[6] Mann, G. and Spoerry, A. 1974. Studies of surfactant & holesteremia in the Masai. Ame. J. Clinical Nutrition, 27: 464-469.

[7] Shahani, K.M. and Chandan, R.C. 1979. Nutritional and healthful aspects of culture containing dairy foods. J. Dairy Sci. 62: 1685-1694.

[8] Penney, V., Henerson, G., Blum, C., and Johnson-Green, P. 2004. The potential of phytopeservatives and nisin to control microbial spoilage of minimally processed fruit yogurts, *Innov. Food Sci. Emerg. Technol.* 5 (2004) 369-375

[9] Chandan, R.C., and Shahani K.M., 1993. Yogurt. In: *Dairy Science and Technology Handbook: Product Manufacturing, Vol. 2,* Y.H. Hui (Ed). New York: Wiley-VCH. pp.1-56.

[10] Bardale, P.S., Waghmare, P.S., Zanjad, P.N., and Khedkar, D.M., 1986. The preparation of shrikhand like product rom skin chakka by fortifying with fruit pulps, *Indian* J. 38,431-432.

[11] Barnes, D.L., Harper, S.J., Bodyfelt, F.W., and McDaniel, M.R., 1991. Correlation of descreptive and consumer panel flavour ratings for commercial prestirred stawberry and lemon yogurts, J. Dairy Sci. 74,2089-2099.

[12] Neilson, S.S. 1998. Food Analysis. 2nd edition. Maryland: Aspen Publishers.

[13] Winton, A.L. and Winton, K.B. 2001. Techniques of Food Analysis. Updesh Purohit for Agrobios, Jodhpur Publication.

[14] A.O.A.C (1995) Official Methods of Analysis. Association of Official Analytical Chemists. 16th edition. Washington D.C

[15] Copur, O.U., Korukcuoglu, M., and Donmez, G. 1994. Utilization of some stabilizers in the manufacturing of yogurts with fruit, Uludag Universitesi Ziraat Fakultesi Dergisi, 10, 71-82.

[16] Mbaeyi, I.E. and Anyanwu, L.N. 2010. Production and evaluation of yogurt flavored with solar-dried bush mango (irvingia gabonensis) pulp. J Tropical Agriculture, Food, Environment and Extension Vol. 9 Number 2 PP. 137-146.

[17] Moon-Sukkim, Eun-Suk Ahn and Shin-Dong. 1993. Physicochemical properties of commercial Yogurt in Korea. Korean J. Food Sci. 25 (4):340-344.

[18] Bonczar,G., Wszolek, M., and Siuta, A. 2002. The effects of certain factors on the properties of yogurt made from ewe's milk. *Food Chem*, 79, 85-91.

[19] Kucukoner, E. and Tarakci, Z. Influence of different fruit additives on some properties of stirred yogurt during storage. *Milchwissenschaft*, 59, 159-161, 2004.

[20] Bakirci, I. and Kavaz, A.: An investigation of some properties of banana yogurts made with commercial ABT-2 starter culture during storage. *Int J Dairy Technol*, 61, 270-276, 2008.

AUTHORS

First Author – S.T.S.K. Warakaulle, B.Sc, Department of Livestock & Avian Sciences, Wayamba University of Sri Lanka, email: <saumya.stk88@gmail.com>.
Second Author – W.A.D.V. Weerathilake, Mphil;B.Sc.Special (Hons), Department of Livestock & Avian Sciences, Wayamba University of Sri Lanka,
email: <dammika_kandy@yahoo.com > ..
Third Author – N.R. Abeynayake, Ph. D; M.Sc; B.Sc Special (Hons), Department of Agribusiness Management, Wayamba University of Sri Lanka,
email: <rabeynayake@hotmail.com>

Correspondence Author – W.A.D.V. Weerathilake,email: <dammika_kandy@yahoo.com>, Tel: +94 (0)77 989 4142