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STUDIES ON DEVELOPMENT OF WATERMELON JUICE FORTIFIED LOW FAT PROBIOTIC YOGHURT

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Abstract: *Probiotic yoghurt was prepared by using juice of watermelon and the pectin at varying concentration and Lactobacillus Acidophilus used as the probiotic culture. The efforts were made to investigate the influence of watermelon juice, and pectin on physico-chemical, sensory and microbial characteristics. The data generated during present investigation revealed that watermelon juice and pectin use as a novel ingredients in enhancing the quality characteristics of probiotic yoghurt. Yoghurt sample prepared with 10% watermelon juice and 0.30% pectin resulted superior organoleptic as well as chemical characteristics compared to other treated samples, justifying its suitability in watermelon fortified probiotic yoghurt preparation.*

Keywords: *Watermelon juice, low fat probiotic yoghurt, probiotic yoghurt.*

Introduction

Yoghurt is a coagulated milk product obtained by the lactic acid fermentation through the action *of* S*treptococcus Salivarius* subsp. *Thermophilus*, *Lactobacillus Delbrueckii* subsp. *Bulgaricus* from the milk or milk products (FAO/WHO 1977). The milk coagulates when a sufficient quantity of lactic acid is produced. The probiotic yoghurt is fermented milk product with adjuvant microorganisms having probiotic effect. Moreover, yoghurt supplies high quality proteins, also an excellent source of calcium, phosphorus and potassium and contains significant quantities of general vitamins.

Watermelon juice is considered as a healthy drink which is rich in lycopene, minerals and vitamins such as A, B and C. Regular consumption of watermelon juice can increase blood concentration of lycopene and beta-carotene. According to the USDA Nutrient Database (2009), watermelons contain 40% more lycopene (per 100 g) than raw red ripe tomatoes. Watermelons are also a good source of vitamin C with a cup (8 oz) of watermelon juice containing 20% of the daily value for vitamin C. Due to its low acidity and growing conditions, watermelon is regarded as a potentially hazardous food (FDA, 2001).

Recently there has been increasing trends to fortify the dairy product with fruits. Using fruit juice as a functional pigment in fermented milks could be helpful in new product development with array of colors and flavor properties which increase product aesthetic value. Coisson *et al.,* (2005) used *Euterpe Oleracea* juice as functional pigment for yoghurt, which is dark purple in color with high anthocynin and phenolic content. Novel natural pigments, containing potential health-promoting bio-active phenolics, considered as "functional" ingredients for their anti-oxidant and anti-radical activity.

Materials and Methods

Starter Cultures

The freeze-dried yoghurt cultures used for WFPY preparation, viz. *Streptococcus Salivarius* subsp. *Thermophilus* and two probiotic cultures viz. *Lactobacillus Acidophilus* and *L. Bulgaricus* were obtained from National Dairy Research Institute, Karnal, India.

Media for Culture Activation

The *S. Thermophilus*and *Lactobacillus Acidophilus*were activated in litmus milk. The *L. Bulgaricus* were activated using 10% skim milk. (Anonymous. 2008)

Media for differential enumeration

The counts of *S. Thermophilus* were enumerated on ST agar (Composition: 10.0g tryptone; 10.0g sucrose; 5.0g yeast extract; 2.0g K_2HPO_4 and 6 ml of 0.05% bromo-cresol-purple per liter of water, pH adjusted to 6.8 . The MRS-salicin agar was used for the selective enumeration of *L. Acidophilus*.

Skim Milk Powder & Watermelon Fruit

The skim milk powder (SMP) & watermelon fruit were procured from the local market.

Composition of MRS Media

Suspend all ingredients in distilled water and heat to boiling to dissolve the medium completely. Sterilize the medium in autoclave at 15 lbs pressure for 15 minutes.

Ingredients	Grams / Liter
Proteose Peptone	10.0
Yeast Extract	5.0
Beef Extract	10.0
Dextrose	20.0
Tween– 80	1.0
Ammonium Citrate	2.0
Sodium Acetate	5.0
Magnesium Sulphate	0.1
Manganese Sulphate	0.05
Di-potassium Phosphate	2.0

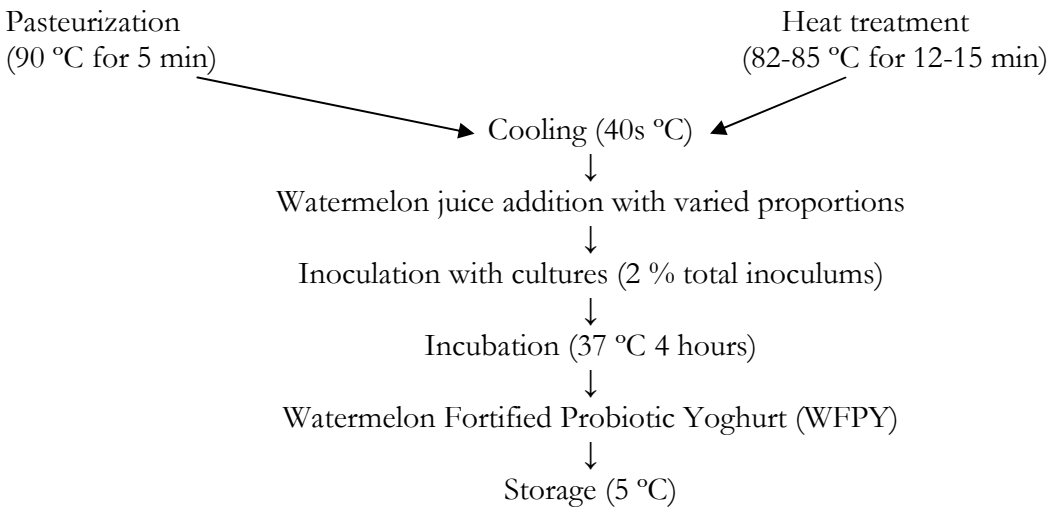
Flow Chart for the Propagation of Cultures

Starter cultures
↓
Preparations of 10% skim milk or MRS broth
↓
Aseptically filling in test tubes (10-20 ml)
↓
Sterilization of test tubes (15 psi/20 min)
↓
Inoculation under aseptic conditions
↓
Incubation (37 ± 1 ºC for 24-48 h)
↓
Mother culture
↓
Storage under refrigeration conditions
↓
Periodic transfer at 1% in the sterilized media
↓
Preparation of bulk cultures from fully activated mother culture
↓
Storage under refrigeration condition

Flow Chart for the manufacturing of WFPY

Watermelon fruits
↓
Extraction of juice
↓

Skim Milk Powder
↓
Gentle mixing with water
↓



Preparation of Low Fat Watermelon Juice Fortified Probiotic Yoghurt (WFPY)

In this investigation there were in all six treatments with one control, combination as described below.

Sample	Concentration (%)
Control	Yoghurt without watermelon juice
W_1C_1	Yoghurt with 5 % watermelon juice
W_1C_2	Yoghurt with 10 % watermelon juice
W_1C_3	Yoghurt with 15 % watermelon juice
W_1C_4	Yoghurt with 20 % watermelon juice
W_2C_s	Yoghurt with 25 % watermelon juice

The best treatment from above blends is utilized for further investigation i.e. addition of pectin in varying concentration.

Addition of Pectin in Low Fat Watermelon Juice Fortified Probiotic Yoghurt (WFPY)

Sample	Concentration (%)
Control	Yoghurt without pectin
W_2C_1	Yoghurt with 0.1 % pectin
W_2C_2	Yoghurt with 0.2 % pectin
W_2C_3	Yoghurt with 0.3 % pectin
W_2C_4	Yoghurt with 0.4% pectin

Results and Discussion

Physical Parameters of Watermelon Fruit

Table 1: Physical characters of Watermelon Fruit

Physical parameter	Specification
Weight of fruit (per fruit)	1.25 kg
Weight of seed (per fruit)	0.04 gms
Weight of flesh ((per fruit)	11%
Fruit flesh %	89.25 %
Length (cm)	15.2 cm
Width (cm)	12.5 cm

Physico-chemical Properties of Watermelon Fruit, Juice & SMP

Table 2: Chemical composition of Watermelon Fruit and SMP

Parameters (%)	Watermelon Fruit	SMP
Moisture	92.33 %	3.02 %
Protein	0.58 %	35.90 %
Carbohydrate	7.83 %	52.30 %
Fiber	0.38 %	Nil
Fat	0.16 %	0.50 %
Ash	0.80 %	8.02 %

Table 3: Physico-Chemical Properties of Watermelon Juice

Parameter	Watermelon Juice Composition
TSS	7.0 °Bx
pH	5.7
Juice yield	74.84 %
Acidity	0.07 %
Lycopene	1.98 mg/kg

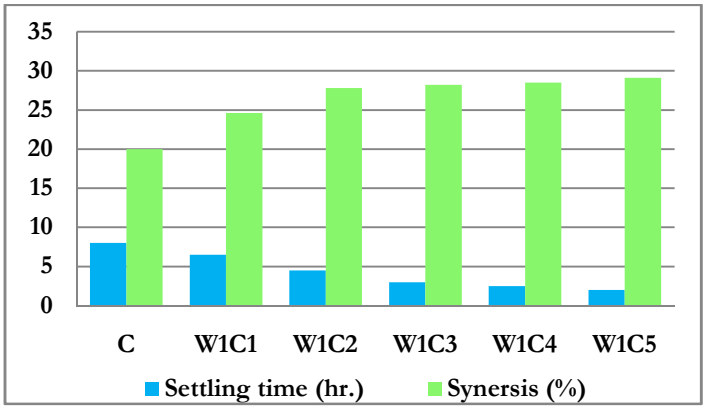
Table 4: Properties of Reconstituted Skim Milk

Property	Reconstituted Skim Milk
pH	6.40
Acidity (%)	0.158 %

Table 5: Settling time and synersis of watermelon fortified low fat set probiotic yoghurt

Treatments	Settling Time (hrs.)	Synersis (%)
Control	8	20
W_1C_1	6.5	24.60
W_1C_2	4.5	27.80
W_1C_3	3	28.20
W_1C_4	2.5	28.50
W_1C_s	2	29.10

Figure 1: Settling time and synersis of watermelon fortified low fat set probiotic yoghurt



Effect of SMP and Watermelon Juice on the Physico-Chemical Properties of WFPY

Table 6: Effect of addition of different concentration of watermelon juice on Chemical composition of low fat set probiotic yoghurt

Yoghurt	pH	Acidity (%)	Moisture (%)	Fat (%)	Protein (%)	TSS (^{0}Bx)
Control	4.47	1.03	85.91	1.18	3.24	14.58
W_1C_1	4.36	1.19	75.43	1.26	3.28	18.30
W_1C_2	4.41	1.12	77.18	1.53	3.36	22.50
W_1C_3	4.49	1.08	78.91	1.69	3.45	25.80
W_1C_4	4.53	0.97	79.54	1.76	3.53	26.25
W_1C_5	4.57	0.95	79.89	1.82	3.61	26.90

Table 6 shows the pH content of sample 'W_1C_5' (4.57) was maximum as compared to other samples. This may be due to the more carbohydrate content of the sample increased with addition of watermelon after fermentation. Zekai Tarakci and Erdogan Kucukoner (2003) reported pH values of fortified yoghurt in the same range obtained in present study.

The acidity of fortified yoghurt increased as the concentration of fortification decreased. The acidity is increased from 0.95 % to 1.19 %. The values of acidity were in close agreement with Neil *et al.,* (1979) who observed an increase in acidity with decrease in concentration. The increase in acidity shows that, acidity of ingredients influenced increase in acidity of yoghurt.

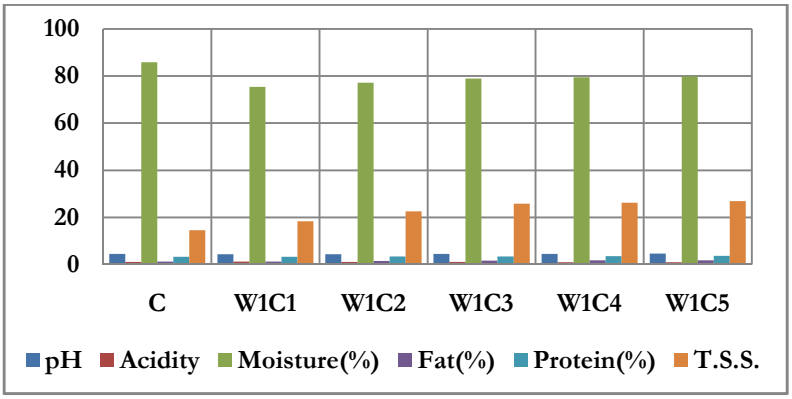
The sample 'W_1C_5' has maximum moisture (79.89 %) was recorded higher moisture. From Table 6 It was also observed that moisture content was increased as rate of concentration of paste increased.

There is significant difference in the fat content of the yoghurt containing watermelon juice. It has been observed that the sample W_1C_5 contained higher fat % *i.e.* 1.82.while sample W_1C_1 (1.18) was recorded minimum fat content as having 5 % watermelon juice as shown in Table 6.

The protein content has obviously increased as the concentration is increased. It has been observed that the sample W_1C_5 contained maximum protein (3.61 %) as the concentration of paste increased and W_1C_1 contained about 3.24 % protein. Zekai Tarakci and Erdoğan Kucukoner (2003) reported protein content of yoghurt in the same range obtained in present study.

From Table 6 it was recorded that the W_1C_1 contained lower total soluble solids (18.3^{0}bx) than other samples. While TSS varied from 18 to 27^{0}bx. Hutkins (2006) obtained the similar results. The total soluble solid has also increased as the watermelon juice concentration has increased.

Figure 2: Effect of addition of different concentration of watermelon juice after fermentation on chemical composition of low fat set probiotic yoghurt



Sensory Evaluation of Stirred Yoghurt Fortified with Watermelon Juice

Table 7: Sensory analysis of yoghurt with different concentration of watermelon juice

Treatments	Appearance	Color	Flavor	Taste	Texture	Overall Acceptability
Control	7.5	7.0	7	7.5	7.5	7.5
W_1C_1	7.6	7.5	7.4	7.6	7.6	7.8
W_1C_2	7.4	7.2	7.6	7	7.4	7.8
W_1C_3	7.4	7.2	7.2	7.2	7.4	7.5
W_1C_4	7.2	7.0	7.0	7.4	7.5	7.4
W_1C_5	6.8	7.0	7.0	7.4	7.5	7.2

The appearance of sample W_1C_1 having higher score (7.6) which was of 25 % juice concentration. Water holding capacity of the curd mass is reduced with the addition of higher concentration of juice, as it affects the protein interaction during coagulation process, resulting into more yields of synersis. This decreases appearance and colour of the product (Kayanush *et al.,* 2003).

It can be observed from Table 7 that difference in colour of the fortified yoghurt was highly significant due to addition of different concentration watermelon juice. It means that as compared to plain yoghurt, colour was improved due to addition of juice after fermentation process. The similar results were obtained in same range (Yeganehzad *et al.*, 2007).

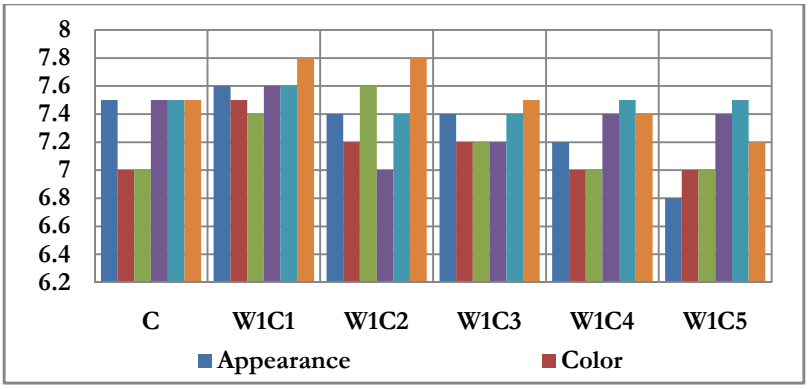
From Table 7 it is observed that flavor of fortified yoghurt was influenced significantly. For flavor, the sample 'W_1C_2' with 10 % juice of watermelon improved. Also, it was shown that increase in concentration resulted in increasing the acidic taste of yoghurt.

The taste of sample 'W_1C_1' (5 % juice) was liked extremely to the judging panels. It means that as compared to plain yoghurt, taste was improved due to addition of watermelon juice after fermentation of milk.

Texture was generally affected due to separation of whey at high level of juice due to production of acids, to give the reduced coagulation and formation of soft and loose textured curd. The score of fortified yoghurt was good as compared to control sample.

As shown in Table 7, W_1C_1 and W_1C_2 sample were superior to control sample (plain yoghurt). It means that as compared to plain yoghurt, overall acceptability was improved due to addition of watermelon juice. Among the all the treatments W_1C_1 and W_1C_2 having the maximum score i.e.7.8 the data obtained from Table 7 it has been observed that as the concentration of paste increased the score of overall acceptability was decreased.

Figure 3: Sensory evaluation of stirred yoghurt fortified with watermelon juice added after fermentation



Effect of SMP, Pectin and Watermelon Juice on the Physico-Chemical Properties of WFPY

Table 8: Effect of SMP, Pectin and Watermelon Juice on the Physico-Chemical properties of WFPY

Yoghurt	pH	Acidity (%)	Moisture (%)	Fat (%)	Protein (%)	TSS (^{0}Bx)
Control	4.47	1.03	85.91	1.18	3.24	14.58
W_2C_1	4.54	0.97	69.37	1.27	3.25	24.2
W_2C2	4.64	0.94	74.19	1.44	3.38	26.0
W_2C_3	4.69	0.87	74.94	1.53	3.42	27.8
W_2C_4	4.72	0.81	77.08	1.57	3.45	28.20

Table 8 shows the pH content of sample 'W_2C_4' (4.72) was maximum as compared to other samples. This may be due to the low carbohydrate content of the watermelon.

The acidity of fortified yoghurt decreases as the concentration of fortification increases. The acidity is decreased from 0.97 to 0.76 %. The increase in acidity shows that, acidity of ingredients influence increase in acidity of yoghurt.

The sample 'W_2C_4' has shown maximum moisture (77.08 %). The moisture content has significantly increased as the concentration of the pectin is increased.

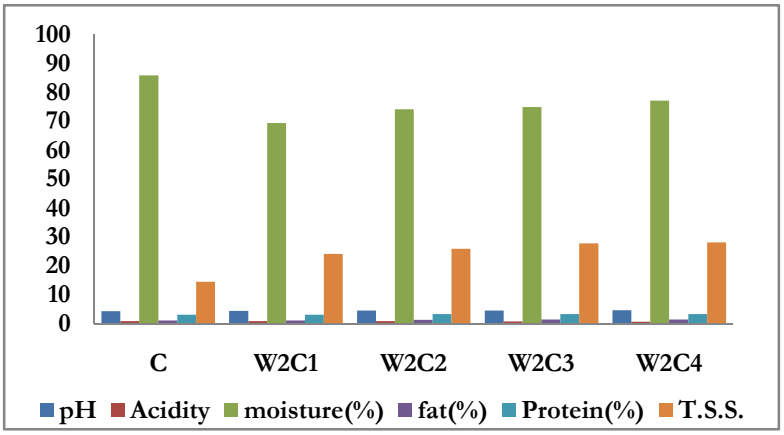
It has been observed that the treatment W_2C_4 contained higher fat % i.e. 1.57 while sample W_2C_s (1.27) was recorded minimum fat content.

Protein content ranges from 3.28 to 3.45 %. It has been observed that the sample W_2C_4 contained maximum protein (3.45 %) as the concentration of juice increased and W_2C_1 contained about 3.25 % protein. Zekai Tarakci and Erdogan Kucukoner (2003) reported protein content of yoghurt in the same range obtained in present study.

The total soluble solid has also increased as the watermelon juice concentration has increased. From Table 8 it was recorded that the W_2C_1 contained

lower total soluble solids (24.2 ^{0}bx) and W_1C_4contained highest total soluble solids (28.20^{0}bx).

Figure 4: Effect of SMP, Pectin and Watermelon Juice on the Physico-Chemical Properties of WFPY



Effect of Pectin on Viscosity & Water Holding Capacity of Watermelon Juice Fortified Probiotic Yoghurt

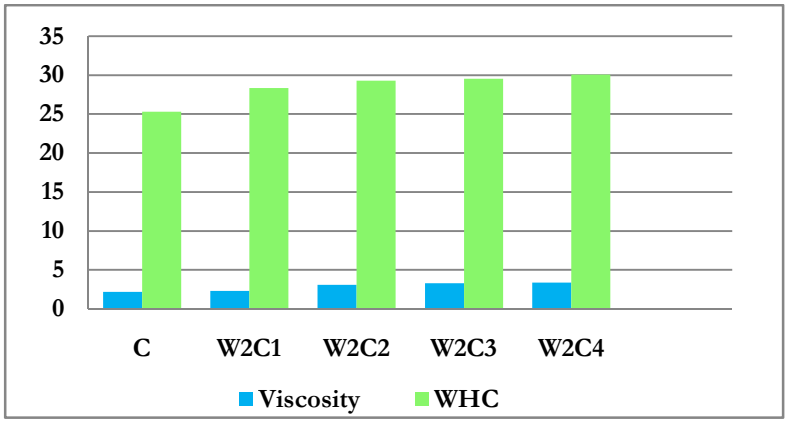
Table 9: Effect of pectin on viscosity and water holding capacity of watermelon juice fortified probiotic yoghurt

Yoghurt	Viscosity (×10³cp)	WHC (%)
Control	2.17	25.32
W_2C_1	2.32	28.35
W_2C_2	3.07	29.29
W_2C_3	3.28	29.53
W_2C_4	3.36	30.08

The range for viscosity varied from 2.32 to 3.36 % respectively. The sample W_2C_1 shows the minimum viscosity (2.32). Table 9 showed that the viscosity of WFPY was increased as concentration of pectin increases.

The range for WHC varied from 28.35 to 30.08 % .The sample W_2C_1 shows the minimum WHC (28.35).Table 9 showed that the WHC of WFPY was increased as concentration of pectin increases.

Figure 6: Effect of pectin on viscosity and water holding capacity of watermelon juice fortified probiotic yoghurt



Sensory Evaluation of Watermelon Fortified Probiotic Yoghurt Fortified With Pectin

Table 10: Sensory analysis of watermelon fortified probiotic yoghurt with different concentration of pectin

Treatments	Appearance	Color	Flavor	Taste	Texture	Overall Acceptability
Control	7.5	7.0	7	7.5	7.5	7.5
W_2C_1	7.5	7.5	7.6	7.8	7.6	7.8
W_2C_2	7.6	7.4	7.2	7.5	7.2	7.3
W_2C_3	7.2	7.2	7.2	7.2	7.4	7.3
W_2C_4	7.2	7.0	7.0	7.3	7.4	7.2

The appearance of sample W_2C_1 having higher score (7.5) which was from of 10 % watermelon concentration. Water holding capacity of the curd mass is reduced with the addition of higher concentration of paste, as it affects the protein interaction during coagulation process, resulting into more yields of synersis. This decreases appearance and colour of the product. (Kayanush *et al.,* 2003).It means that as compared to plain yoghurt, appearance was improved due to addition of juice and pectin at 0.1 level that to after fermentation process.

It can be observed from Table 10 that there is no significant difference in a color due to addition of different concentration pectin.

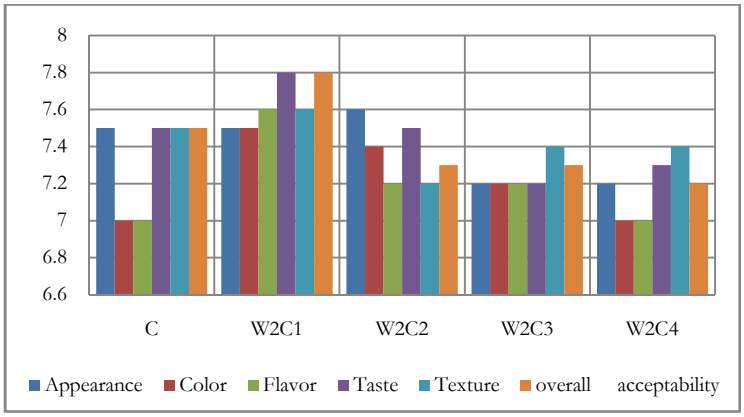
Increase in concentration resulted in increasing the acidic taste of yoghurt. So, the minimum concentration should be preferred for the maximum flavor score.

The taste of fortified yoghurt was influenced significantly due to addition of pectin. From Table-10 it is shown that the sample 'W_2C_1' (7.8) with 0.1 % pectin were scored maximum in taste.

It is revealed that, higher level of concentration of fruit paste had reduced the score for texture. But the addition of pectin into the yoghurt improves the texture.

As shown in Table 10, W_2C_1 was superior to control sample (plain yoghurt) .W_2C_2 and W_2C_s have similar score as that of control sample (7.3). It means that as compared to plain yoghurt, overall acceptability was improved due to addition of pectin.

Figure 7: Sensory evaluation of watermelon fortified probiotic yoghurt fortified with pectin



Effect of Watermelon Juice & SMP on the Microbiological Properties of WFPY

Table 11: Microbiological Counts (× 10^8 cfu / ml)

Yoghurt	*Streptococcus Thermophilus*	*Lactobacillus Acidophilus*
C	8.1	10.5
W_2C_1	17.5	15.7
W_2C_2	18.3	16.8
W_2C_3	25.7	24.3
W_2C_{ss}	27.5	25.9

The range of *Lactobacillus Acidophilus* counts varied from 15.7×10^8 to 25.9×10^9 cfu/ml in different samples respectively. Babu *et al.* (1992) reported that addition of tomato juice to skimmed milk stimulated the growth of *L. acidophilus and* resulted in higher viable counts, shorter generation time, and improved sugar utilization with more acid production and lower pH. The microbial count of *Lactobacillus Acidophilus* found to be maximum in W_2C_4 while minimum in W_2C_1, which indicate that the viability of *Lactobacillus Acidophilus* increases with the increasing the watermelon juice concentration.

The range of *Streptococcus Thermophilus*counts varied from 17.5 $\times10^8$ to 27.5×10^8 c.f.u/ml, for WFPY. The results obtained were in agreement with Rybka and Kailasapathy.

Conclusion

Experiments were conducted as per desired experimentations, to study the effect of Watermelon juice and SMP on the physico-chemical, microbiological, sensory analysis and storage of low-fat set Watermelon fortified probiotic yoghurt (WFPY) using *Lactobacillus Acidophilus* as adjuvant culture either in manufacturing processes and the efforts made on incorporation of the pectin to improves the body of yoghurt. It is concluded that, watermelon juice and pectin use as a novel ingredients in enhancing the quality characteristics of probiotic yoghurt. Yoghurt sample prepared with 10% watermelon juice and 0.30% pectin resulted superior organoleptic as well as chemical characteristics compared to other treated samples, justifying its suitability in watermelon fortified probiotic yoghurt preparation.

References

A.O.A.C. (1984) Official methods of analysis, 14th edition.Association of Official Agricultural Chemist. *Inc., Arlington, V. A.*

Anonymous. (2008) Catalogue NDRI, Karnal. Procedure to prepare agar for enumeration of bacteria.

Babu, V., B.K. Mital, and S.K. Grag. (1992) Effect of tomato juice addition on the growth s activity of *Lacobacillus acidophilus. Int. J. Food Microbiol.*17(1), 67-70

Coisson, J.D., Travaglia, F., Piana, G., Capasso, M.s & Arlorio, M. (2005) *Euterpeoleracea* juice as a functional pigment for yogurt. Food Research International 38, 893–897.

FAO/WHO (1977) Report joint FAO/WHO expert committee on the code of principles concerning milk and milk products. FAO/WHO, Rome.

Food and Drug Administration (FDA).(2001) Evaluation and definition of potentially hazardous foods. http://vm.cfsan.fda.gov/~comm/ift4-3.html. Accessed on March 24, 2009.

Hutkins Robert (2006) Making yoghurt at home, Institute of Agriculture and Natural Resources,Linconl

Kayanush JAryana (2003) Effect of solid content on synersis of yoghurt.International Journal of Dairy TechnologyVolume 56 Issue 4, Pages 219 – 222.

Neil, J. Deck, H. Klen and Cynne, B. (1979).Consistency and compositional characteristics of commercial yoghurt. J. Dairy Sci., 62; pp: 1032-1036.

Rybka, S. & Kailasapathy, K. (1995) The survival of culture bacteria in fresh and freeze dried AB yoghurts. Australian Journal of Dairy Technology, 50, 51-57.

United States Department of Agriculture (USDA) Nutrient Lab. Watermelon. http://www.ars.usda.gov/main/site_main.htm?modecode=12-35-45-00. Accessed March 24, 2009.

Yeganehzad Samira, Mazaheri Mostafa and Shahidi Fakhri (2007) Studying microbial, physiochemical and sensory properties of directly concentrated probiotic yoghurt. African Journal of Agricultural Research Vol. 2 (8), pp. 366-369.

Zekai Tarakci and Erdogan Kucukoner (2003) Physical, chemical, microbiological and sensory characteristics of some fruit-flavored yoghurt. YYU Vet Fak Derg, 14 (2); pp: 10-14.