

Original Research Article

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Process Standardization and Quality Evaluation of Yogurt Fortified With Noni Juice

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ABSTRACT

The present study was planned to investigate the possibility of noni juice incorporation in yogurt prepared with artificial sweeteners and to observe its effects on physico-chemical, sensorial and microbiological quality. Yogurt was prepared by standardized method with 3 per cent inoculum and fermented at 45°C temperature with different concentration of Noni juice (viz. 3, 6 and 9 per cent). The results revealed that increase in addition of Noni juice linearly increased the setting time, acidity and synergies of the product while pH and TSS decreased. Proximate analysis showed that moisture content increased with increasing concentration of noni juice while fat, protein, carbohydrates and ash contents were not significantly affected. It was concluded that yogurts prepared from cow milk with addition of 3 per cent noni juice found to be more acceptable than other treatments. Moreover, noni juice incorporated also resulted in better microbiological quality of yogurt.

Keywords

Yogurt fortification,
Noni juice,
Lactobacillus
bulgaricus,
Streptococcus
thermophilus

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Introduction

Yogurt is a cultured dairy product generally fermented with mixture of two species i.e. *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. It has soft, friable custard like consistency and a clean distinct acid flavour

(Kadam *et al.*, 2010). Yogurt supplies high quality of protein and is excellent source of calcium, phosphorus and potassium (Meydani, 2006). In industrialized world, yogurt is generally prepared using cow's milk. Whole milk, partially skimmed milk, skim milk or whole milk enriched with

cream may be used, to lower or raise the fat content as desired. The main processing steps involved in Yogurt manufacturing include standardization of milk (fat and protein content), homogenization, milk heat treatment, incubation, fermentation, cooling and storage. The purpose of the present study was to optimize inoculum (*Streptococcus salivarius* subsp. *thermophilus* and *Lactobacillus delbrueckii* spp. *bulgaricus*) level, setting temperature and sugar concentration in development of cow milk yogurt.

Noni (*Morinda citrifolia*), Family-*Rubiaceae*, originated in India and is now distributed in the continents of Asia, Australia, South America and Africa.

Polynesians identified the medicinal uses of noni fruits. Noni is also known as pain killer bush, head ache tree due to its excellent medicinal properties (Morton, 1992; Wang and Brett, 2002). It has been used as food and medicinal purposes for more than 2000 years ago (Wang and Brett, 2002; Mathivanan *et al.*, 2005; Satwadhari *et al.*, 2011). Noni fruit contains several phytochemicals, of which 160 compounds have already been identified. It also contains organic acids, several anthraquinones for e.g., damnacanthal, phenolic compounds and alkaloids. The fruit of *M. citrifolia* contains high amount of calcium, potassium, phosphorus and magnesium. Due to its high nutritional content, the fruit is now used for the extraction of juice, which is used as health drink throughout the world (Wang and Su, 2001).

In the view of the promising health benefits of probiotic bacteria, artificial sweeteners, Noni fruit having high dietary fiber content, these natural functional ingredients are incorporated in cow milk to develop fruit

fortified low calorie Yogurt which will be acceptable as therapeutic food product using fermentation technology.

Materials and Methods

Cow milk of *Red Sindhi* breed was obtained from local market. Chemicals used in this investigation were of analytical grade.

Pure culture of *Streptococcus salivarius* subsp. *thermophilus* and *Lactobacillus delbrueckii* spp. *bulgaricus* were obtained from National Chemical Laboratory, NCIM, Pune (MS) India.

The pure cultures were subcultured on slants prepared from MRS media in laminar flow (De Mann *et al.*, 1960) and the culture which was obtained from sub culturing and inoculated in conical flask containing sterilized 50ml cow milk and the milk was incubated at 45° C till the firm coagulum was formed.

Batch culture was prepared by inoculating 3 per cent of mother culture into 100 ml of sterilized cow milk and incubated at 45° C till firm coagulum was formed. The bulk culture was stored in refrigeration.

Preparation of Noni Fortified Yogurt

Experimental yogurt samples were prepared as per the method described by Patil *et al.*, (2009) with the suitable modifications as follows:

Standardization

The process was begun with standardization of components of milk. A fat level was adjusted to 2.0-3.5 % by separating cream with the help of centrifuge. The serum solids content of the milk were increased to

10.5-11.5 % by adding skim milk powder and casein at the rate of 4 % and 0.3 % respectively.

Homogenization

Homogenization was operated at about 200 kg/cm² pressure and temperature 55°C to retards fat separation.

Addition of Sugar

The sugar was added at the rate of 10 per cent.

Heat Treatment

The homogenized milk was heated to about 90-95° C for 10 min and cooled to 42° C to destroy the pathogenic organisms.

Standardized formulation for Yogurt preparation

Inoculation

The active starter culture was inoculated in 1:1 ratio of *St. thermophilus* and *L. bulgaricus* at the rate of 3% of total inoculation and mixed well with the help of a stirrer (Atta *et al.*, 2009).

Incubation

The milk is incubated at different temperatures of 45°C for the period till the desired acidity is attained.

Packaging and Storage

Yogurts were packed in plastic cups, cooled and stored at about 5°C. Various parameters of Yogurt preparation are summarized by Deshpande *et al.*, 2014 and recipe is given as follows:

| Ingredients | Control | N1 | N2 | N3 |
|----------------------|----------------|-----------|-----------|-----------|
| Cow Milk (ml) | 100 | 97 | 94 | 91 |
| Noni Juice (ml) | 00 | 03 | 06 | 09 |
| Inoculum (ml) | 03 | 03 | 03 | 03 |
| Sweetener (g) | 10 | 10 | 10 | 10 |
| Incubation Temp (°C) | 45 | 45 | 45 | 45 |
| Time (hr) | 06 | 06 | 06 | 06 |

Analysis of Yogurt

Setting time of Yogurt

The setting time of sample was recorded from the time of incubation to just coagulum formed and it was recorded in hours (h).

Determination of syneresis

Syneresis was measured by the method of Modler *et al.*, (1983). A mass of 25 g of Yogurt was weighed onto a wire mesh screen placed over a funnel in a graduated cylinder.

Samples were placed in a refrigerator at 6°C immediately after weighing. Syneresis (ml/100g) was expressed as the volume of exudate collected after 2 hr of refrigeration.

Physico-chemical analysis

Physico-chemical of yogurt such as total soluble solids (TSS), pH and acidity were determined as per standard (A.O.A.C., 1990).

Sensory Evaluation

15 semi-trained panel members having previous experience of sensorial evaluation of food products were selected for carrying out the sensory evaluation and asked for

description sensory evaluation of yogurt for appearance, color, flavour, taste and texture as overall acceptability as followed by Kadam *et al.*, (2010).

Results and Discussion

The present investigation was carried out for preparation and standardization of noni juice fortified yogurts. Further, it was studied for its physico- chemical properties, sensory characteristics.

The qualities of yogurt such as physical properties, chemical composition and sensory acceptability were determined.

Physico-chemical properties of fruit juices

The data pertaining to the physico-chemical properties of noni fruit juice is recorded and presented in Table 1.

The color characteristics of fruit juices were recorded by using tintometer readings of R+Y+B. The results indicate that values recorded for noni juice 10.4R, 10.2Y and 3B. It was further observed that noni juice contain clear and sparkling solution.

TSS, pH and acidity of Noni juice was observed to be 8.60° Bx, 3.62 and 1.25% respectively.

The results for noni juice and pineapple juice were in close agreement with the studies of Yanine *et al.*, (2006).

Proximate composition of Milk and Noni Juice

The data pertinent to proximate composition of noni and pineapple juice is reported and presented in Table 2. The proximate analysis of noni and pineapple fruit juice revealed

that there was significant difference in nutrient content of milk and noni juice.

The results for noni juice were in close agreement with the studies of Yanine Chan-Blanco *et al.*, (2006). The purpose of finding the nutritional composition was to study the effect of addition of Noni juice concentrations on physico-chemical as well as sensory qualities of product.

Effect of addition of noni fruit juice on physicochemical properties of yogurt

The physico-chemical properties of the Yogurt samples reflect the effectiveness of the process and suitability of selected ingredients.

The physico- chemical properties of noni juice fortified Yogurt samples prepared from the different proportions of ingredients are presented in Table 3.

The setting time of samples was found to be increased with an increase in concentration of fruit juice fortification. Similar findings for syneresis of carrot juice fortified yogurts were cited by Salwa *et al.*, (2004) in their scientific literature. Moreover, the lesser Syneresis value indicates the better quality of prepared yogurts as it affects other physico-chemical properties of product. It is found from the values that the total soluble solids content of juice fortified yogurt samples decreased with the increase in the concentration of added juice.

The acidity of fortified yogurt samples increased with the decrease in total solids content of samples. This may be attributed to the increase in the availability of moisture for activity of starter.

The values show that the pH of the fruit juice fortified Yogurt samples went on

decreasing as the acidity of Yogurt samples increased. This may be due to increased rate of fermentation and the presence of lactic acid producing organisms.

In general, it could be observed that increase in addition of noni juice linearly increased the setting time, acidity and syneresis of the product while the parameters like pH and TSS decreased with increasing concentration of noni juice.

Effect of addition of noni fruit juice on proximate composition of yogurt

The proximate compositions of noni juice fortified yogurts show their nutritional constituents which significantly affect its quality characteristics and are presented in Table 4.

Noni juice increased moisture content while TSS, protein, fat, carbohydrate and ash content decreased. The moisture content of fortified yogurt samples was found to be increased with increasing concentration of Noni juice, whereas total solids content was found to be decreased.

The fat, protein, carbohydrates and ash contents were not significantly affected; however all these parameters were found to be decreased. The accepted samples N1 contained moisture 85.27%, total solids 14.23%, protein 3.21%, fat 3.76%, carbohydrate 5.17% and ash 0.74% per cent respectively.

Effect of addition of Noni fruit juice on sensory qualities of Yogurt

The effect of addition of noni fruit juice on sensory qualities was studied and the mean score values of sensory qualities of noni fruit juice fortified Yogurts are presented Table 5.

The juice fortified yogurts were analyzed for their organoleptic acceptance by semi-trained panel members with respect to the characteristics such as appearance, color, flavor, taste, texture and overall acceptability. All these organoleptic properties of Yogurts were decreased as juice concentration increased in noni juice fortified yogurt. Among all the fortified samples, the Yogurt with 3 per cent noni juice was found superior than other two fortified Yogurt samples. In case of Texture, lower concentration of juice does not affect the texture so much where as higher concentration adversely affected the texture. In case of taste, the samples with lower juice concentrations were acceptable than samples with higher juice concentrations.

This may be due to the bitterness causing chemical compounds which were present in Noni juices. The higher overall acceptability was found for the sample N1 to which 3 per cent noni juice was added after fermentation over the control.

Microbial quality of Noni fortified Yogurts

Yogurt prepared from different concentrations of artificial sweetener and noni fruit juice were evaluated for microbial quality as total plate count, total *coliform* count and *yeast* and *mold* count. The results obtained were recorded as colony forming unit per gram of sample i.e. cfu/g for total plate count and *yeast* and *mold* count and most probable number per gram i.e. MPN/g for total *coliform* count reported in Table 6. The sample preparations for microbiological analysis were carried out by using serial dilution technique. Among all the samples prepared using different dilutions, the samples of the dilutions 10^6 , 10^3 and 10^2 were selected for the measurement of total plate count, total *coliform* count and *yeast* and mold count respectively.

Table.1 Physico-chemical properties of Noni fruit juice

| Physico-chemical Properties | Result |
|-----------------------------|----------------|
| Color | 10.4R+10.2Y+3B |
| T.S.S. (%) | 8.60 |
| pH | 3.62 |
| Acidity (%) | 1.25 |

Table.2 Proximate composition of Noni fruit juice and Cow Milk

| Parameters | Noni Juice | Cow Milk |
|-------------------|------------|----------|
| Moisture (%) | 95.93 | 85.94 |
| Protein (%) | 0.43 | 3.42 |
| Fat (%) | 00 | 4.46 |
| Carbohydrates (%) | 3.45 | 5.02 |
| Ash (%) | 0.23 | 0.71 |

Table.3 Physico-chemical properties of yogurt fortified with noni fruit juice

| Parameters | Samples | | | |
|-------------------|---------|-------|-------|-------|
| | Control | N1 | N2 | N3 |
| Setting Time (hr) | 6.0 | 6.17 | 6.25 | 6.41 |
| Synersis (%) | 3.0 | 3.6 | 4.2 | 4.7 |
| T.S.S. (%) | 22.50 | 22.20 | 21.85 | 21.60 |
| pH | 4.47 | 4.43 | 4.37 | 4.32 |
| Acidity (%) | 0.81 | 0.83 | 0.87 | 0.92 |

Table.4 Proximate composition of yogurt fortified with noni fruit juice after fermentation

| Parameters (%) | Samples | | | |
|----------------|---------|-------|-------|-------|
| | Control | N1 | N2 | N3 |
| Moisture | 84.68 | 85.37 | 85.96 | 86.72 |
| Total Solids | 15.02 | 14.23 | 13.57 | 11.89 |
| Protein | 3.52 | 3.21 | 3.08 | 2.92 |
| Fat | 3.85 | 3.76 | 3.62 | 3.57 |
| Carbohydrates | 5.62 | 5.17 | 4.74 | 4.27 |
| Ash | 0.77 | 0.74 | 0.71 | 0.68 |

Table.5 Effect of addition of noni juice on organoleptic qualities of yogurt

| Samples | Appearance | Color | Flavor | Taste | Texture | Overall Acceptability |
|------------------|-------------|-------------|-------------|-------------|-------------|-----------------------|
| Control | 8.8 | 8.6 | 8.5 | 8.7 | 8.8 | 8.8 |
| N1 | 8.1 | 8.3 | 8.4 | 8.4 | 8.0 | 8.1 |
| N2 | 7.9 | 7.3 | 7.5 | 7.8 | 7.2 | 7.5 |
| N3 | 7.4 | 7.3 | 7.4 | 7.3 | 7.1 | 7.1 |
| Mean | 8.06 | 7.88 | 7.85 | 8.05 | 7.78 | 7.90 |
| S.E. | 2.54 | 2.59 | 2.65 | 2.79 | 2.32 | 2.52 |
| C.D. at 5% level | 7.02 | 7.19 | 7.35 | 7.74 | 6.44 | 6.98 |

Table.6 Effect of noni juice fortification on microbial quality of yogurts

| Samples | Total Plate Count (cfu/g) | Total Coliform Count (MPN/g) | Yeast and Mold Count (cfu/g) |
|---------|---------------------------|------------------------------|------------------------------|
| Control | 64 | 27 | 45 |
| N1 | 75 | 29 | 51 |
| N2 | 82 | 25 | 47 |
| N3 | 87 | 23 | 42 |

Values illustrated in Table 6 indicated the growth of microorganisms in both control Yogurt and Yogurt with noni fruit juice. It is also observed that total plate count increased with an increase in fruit juice concentrations. It was in the range of 75 to 87 cfu/g in noni juice fortified Yogurts and 83 to 91 cfu/g in pineapple juice fortified Yogurts. The presented values indicated that *coliform* organisms were detected in control Yogurt. *Coliform* counts markedly decreased from 29 to 23 MPN/g in noni juice fortified Yogurts with an increase in added juice concentrations. There were significant differences in *Coliform* count between control yogurt (27 MPN/g) and yogurt with fruit juices.

In case of noni juice fortified Yogurt this may be due to the inhibitory effect of noni upon *Coliform* organisms. In addition, noni is considered as an antibacterial agent against pathogenic microorganisms (Wang and Brett, 2002) especially intestinal

pathogens (Bushnell *et al.*, 1950). These pathogens may get access into Yogurt either before or even after processing rendering the product unsafe for human consumption.

The illustrated values indicated that *yeast and mold* counts decreased with increased noni juice concentrations from 51 to 42 cfu/g in respective fortified yogurts.

There was significant difference in yeast and mold count between plain and Yogurt with fruit juices. Noni exhibited significant antimicrobial and antifungal activity against various strains of bacteria and fungi (Gerson and Paul, 2002). Similar findings for fruit juice fortification were cited by Salwa *et al.*, (2004) in scientific literature.

Thus in the light of the scientific data of the present investigation, it may be concluded that the Yogurts prepared from cow milk with addition of 3 per cent noni juice found to be more acceptable than other treatments.

Moreover, Noni juice incorporated also resulted in better microbiological quality of Yogurt.

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