ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

Volume 8
Issue 2
2023

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UDK 637.138:637.35.04

DEVELOPMENT OF TECHNOLOGY TO INCORPORATE DEHYDRATED MURUNGA LEAF POWDER IN PANEER CHEESE

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Abstract:

Objective. Murunga (*Moringa oleifera*) is a popular plant and the leaves and fruits are very famous for food but it is underutilized in Sri Lanka even though it has some functional properties. It has some essential oil fractions which provide functional properties. This study was carried out to develop a technology to incorporate Murunga leaf powder in paneer cheese and analyze the chemical and microbial composition, and its' acceptability using (soft and hard paneer). Preparation of paneer was done in a usual way and citric acid was used as a coagulant for all treatments and treated with 0.50, 1.00, 1.50, and 2.00% of Murunga leaf powder for this experiment named T^1 to T_4 respectively. Sensory analysis was conducted (30 panelists) by using hedonic scale (5-point) to evaluate the acceptance level of Murunga incorporation in paneer.

Methods. Cow milk was used for this experiment and fat, and solid non-fat of that milk were analyzed using the Gerber method and standard equation to find Solid non-fat. To produce quality paneer cheese it is recommended to add 0.08-0.15% of ($CaCl_2$) Calcium chloride into the milk to induce coagulation.

Results. The study was conducted to characterize the paneer by having chemical analysis of the Murunga leaf powder incorporated paneer made with different percentages. The protein contents were analyzed just after 10^{th}, 20^{th}, and 30^{th} days in ambient conditions. It shows that there were no significant differences in the protein percentages but slight rises were observed in pH, reduction in the total plate counts with Murunga leaf powder added paneer sample compared with control. Also, coliform counts were not observed throughout the storage period but the sensory analysis showed that the flavor, color, odor and overall acceptability of samples were found significantly different ($P<0.05$). This illustrates that the Murunga leaf powder incorporated paneer has high acceptability and could be potentially used as a functional ingredient, especially for antimicrobial activity, extending the shelf life and increasing the antioxidant ability in paneer and T_3 was selected as the best percentage for paneer cheese.

Conculusion. Dehydrated Murunga leaf powder added to paneer has high acceptability especially T_3 is identified as the best percentage. Also, it has effects on self-life improvement of paneer due to the inhibitory effect against microbes. Therefore, Murunga leaf powder could be used as a preservative in dairy products. The amount of Murunga leaf powder (1.5%) could be considered the acceptable amount for paneer cheese production.

Keywords: Murunga leaf powder, paneer cheese, antimicrobial activity, shelf life.

Introduction. Paneer is a kind of cheese product produced by heat treatment of milk and acid coagulation. For the purpose of acid; lactic, citric, tartaric and acetic acid are usually used in the industries. Organic acid is also important in paneer production because of chemical hazards. Organic acids such as lactic or its salt, citric, lime and lemon juice are used as coagulating agents in paneer manufacturing. The by-product formed during the processing is named whey which is removed by draining through filtration and pressing mechanically to have a hard paneer and keep it for a long time. It is having so many nutrients such as protein, fat, so many minerals and vitamins [1]. Paneer cheese is having milk constituents but there is a loss of lactose, water soluble proteins, some vitamins and minerals [2]. The chemical composition of paneer is 22–25% fat and 16–18% protein and a lower level of around 2.0–2.7% of lactose [3].

So many techniques studied and developed to process of paneer according to the consumer demand, and also to improve functionality, bioactivity and sensory attributes. Pasteurization of milk reduces the harmful microbes and slightly denatures proteins apeacially whey and reduces solubility of colloidal form of calcium phosphates [4].

Functional ingredient-added paneer is not available in the market and it is having less value addition due to its shelf life being limited to a maximum of one month. It is rich in antioxidant compounds. Isothiocyanates is a component which has the antibiotic and anti-carcinogenic properties [5]. The anti-nutritional factors are available in Murunga leaf powder such as tannins, lecithins and protease inhibitors. Also, they have a balanced amount of functional amino acids, vitamins A, and C sources, and antioxidants [6]. Murunga leaf extracts are having 13.9% of Hexacosane, 13.3% of pentacosane and 11.4% heptacosane [23]. These are essential oils, and the relevant components of the oil were obtained from Murunga leaves in another research where pentacosane (17.4%), hexacosane (11.2%) and (*E*)-phytol (7.7%) [24].

Therefore, this study was planned to incorporate Murunga leaf powder in different percentages 0.50, 1.00, 1.50 and 2.00 names as T_1 to T_4 respectively to the paneer cheese to check the possibility of consumer acceptability and functionality.

Methods. Cow milk was used for this experiment and fat, and solid non-fat of that milk were analyzed using the Gerber

method and standard equation to find Solid non-fat. To produce quality paneer cheese it is recommended to add 0.08-0.15% of ($CaCl_2$) Calcium chloride into the milk to induce coagulation. Also, such treatment is increasing the final output of paneer. For the purpose of producing paneer cheese, milk was optimized with 4.5% fat standard levels using the Pearson square method of standardization technique at standard heating at 90ºC temperature [7]. Then the milk was cooled down to a coagulation temperature of around 40ºC, and 0.2% of citric acid was added to the milk while agitated the solution manually and gentle stirring was done for 5 minutes. The whey was drained and separated. Coagulum was taken and allowed to settle for 10 minutes.

Whey is the byproduct obtained from paneer cheese making was filtered and drained off by using a cheese cloth. Soft paneer curd was incorporated with Murunga leaf power (0.50, 1.00, 1.50 and 2.00% and 0% control sample). These paneer mix were subjected a pressure (2 kg/cm^2) for 15-20 minutes to have hard paneer [7]. The recommendation for hard paneer making and soft paneer was not subjected to any pressing. The paneer cheese was cut into $3cm^3$ cubic sizes for further chemical, microbial and sensory analysis.

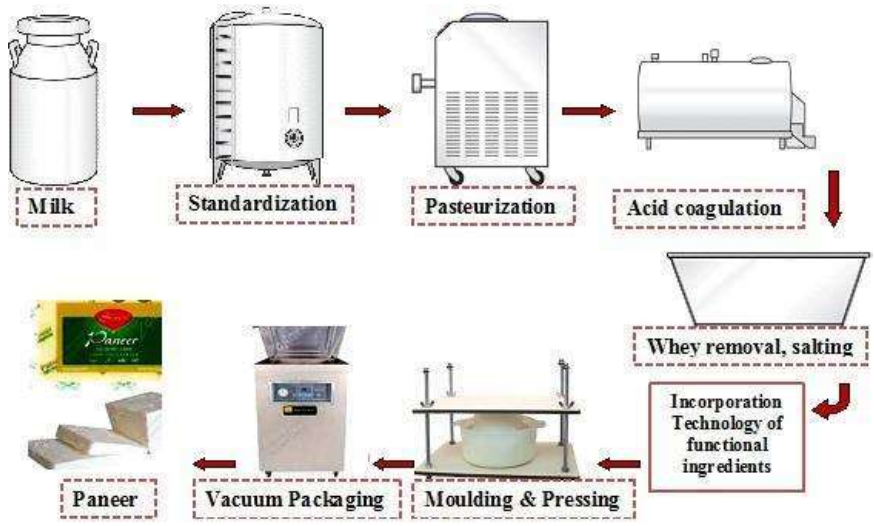

Figure 1. Production flow and technology to incorporate Murunga leaf powder

Each replicate was divided into equal sizes to evaluate sensory, microbial properties and Physico-chemical parameters. Total Coliform Count (TCC) was done by using the Spread plate method, and Total Plate Count (TPC) was done by using the pour plate method as explained in the article [9,10]. Shelf life evaluation was done at an interval of 10 days from the 1st, to the 30th days. Chemical analyses such as titratable acidity, and pH (Model 230A+) [12] were done for the prepared samples and control samples.

The sensory evaluation was conducted to find out the best percentage of Murunga treatment and findout the self-life of 4 treatments and control. A sensory panel of 30 untrained panelists were used for this experiment and color, odour, texture, smell and overall acceptability were evaluated (5 points Hedonic scale) [13]. The non-parametric statistic was conducted by using Minitab software and tested using CRBD -Complete Randomized Block Design.

Table 1

Research plan

Experiment (100 g of Paneer)	Treatments (Murunga leaf powder) (%)				
	Control	T_1	T_2	T_3	T_4
Hard Paneer	0g	0.50	1.00	1.50	2.00

Results. The study was conducted to characterize the paneer cheese by analysisng the chemical composition, chemical co of the Murunga-added paneer made with different percentages. The primary analysis of the composition of Murunga powder is shown in Table 2. It is identifiable that Murunga leaf has a high amount of carbohydrates and proteins on a dry matter basis. Also, it contains a lot of minerals and vitamins.

Table 2

Proximate composition (Dry Matter basis) of Murunga leaf powder

Composition (w/w)	Percentage (%)
Carbohydrates	52.26 ± 0.35
Proteins	27.18 ± 0.23
Ash	12.10 ±0.22
Lipids	06.15 ± 0.12

The pH of all Murunga added samples showed a slight decrease and affected significantly (P≤0.05) with storage while the Titratable acidity of the paneer samples was not affected (P≥0.05) with storage. The moisture content of the sample was 54.36±3.45 % on day 1 and it was not showing any significant difference with storage or percentage of Murunga leaf powder addition.

Table 3

The chemical composition of the Murunga added hard paneer cheese

Components	Storage period (Days)	Treatment with Murunga leaf powder (in %)				
		Control	T_1	T_2	T_3	T_4
Titratable Acidity	Fresh	0.23±0.01	0.24±0.01	0.24±0.02	0.25±0.01	0.26±0.01
	10	0.24±0.01	0.24±0.01	0.24±0.02	0.25±0.01	0.26±0.01
	20	0.24±0.01	0.26±0.01	0.27±0.02	0.27±0.03	0.27±0.04
	30	0.28±0.01	0.27±0.01	0.27±0.02	0.28±0.03	0.28±0.04
pH		6.45±0.03	6.55±0.03	6.56±0.04	6.57±0.05	6.58±0.06
	10	6.32±0.03	6.37±0.02	6.37±0.03	6.38±0.04	6.38±0.05
	20	6.01±0.03	6.11±0.03	6.11±0.04	6.12±0.05	6.12±0.06
	30	5.84±0.02	5.94±0.02	5.94±0.03	5.97±0.04	5.99±0.05

Table 4

Proximate composition of the Murunga added hard paneer cheese

Components	Storage period (Days)	Treatment with Murunga leaf powder (in %)				
		Control	0.50%	1.00%	1.50%	2.00%
Total Solid (%)	Fresh	37.20±2.51	38.11±2.51	38.11±2.52	38.11±2.53	38.11±2.54
	10	37.61±2.30	38.21±2.30	38.22±2.31	38.26±2.32	38.31±2.33
	20	37.63±2.01	38.23±2.01	38.27±2.02	38.29±2.03	38.33±2.04
	30	37.71±4.01	38.42±4.01	38.42±4.02	38.42±4.03	38.62±4.04
Fat (%)	Fresh	12.50±1.02	12.70±1.02	12.70±1.03	12.71±1.04	12.73±1.05
	10	12.61±1.03	12.71±1.03	12.71±1.04	12.71±1.05	12.73±1.06
	20	12.63±1.03	12.72±1.03	12.72±1.04	12.72±1.05	12.74±1.06
	30	12.64±1.03	12.74±1.03	12.74±1.04	12.74±1.05	12.80±1.06
Crude Protein (%)	Fresh	02.08±0.01	02.13±0.01	02.13±0.02	02.14±0.03	02.20±0.04
	10	02.06±0.01	02.11±0.01	02.14±0.02	02.16±0.03	02.21±0.04
	20	02.07±0.03	02.15±0.03	02.14±0.04	02.17±0.05	02.23±0.06
	30	02.10±0.03	02.20±0.03	02.19±0.04	02.19±0.05	02.23±0.06

The crude protein content and fat contents were not showing significant different for all samples including control samples. This indicated that there was no significant effect of Murunga leaf powder on paneer cheese. There was a slight increase in the fat and protein percentage due to the moisture loss and it was not significantly different with storage and percentage of Murunga leaf powder (P≥0.05).

Table 5

Total plate count and total samples

Sample	Fresh		10 days		20 days		30 days	
	Control	Treatment	Control	Treatment	Control	treatment	Control	Treatment
T_1	$1.08x10^2$	$1.07x10^2$	$1.61x10^2$	$1.10x10^2$	$2.61x10^2$	$1.23x10^2$	$2.13x10^2$	$1.81x10^2$
T_2	$1.08x10^2$	$1.07x10^2$	$1.59x10^2$	$1.09x10^2$	$2.06x10^2$	$1.04x10^2$	$2.26x10^2$	$1.78x10^2$
T_3	$1.06x10^2$	$1.08x10^2$	$1.57x10^2$	$1.08x10^2$	$2.18x10^2$	$0.93x10^2$	$2.25x10^2$	$1.18x10^2$
T_4	$1.06x10^2$	$1.08x10^2$	$1.56x10^2$	$1.08x10^2$	$2.07x10^2$	$1.01x10^2$	$2.15x10^2$	$1.80x10^2$

During the storage, TPC of the samples was increased and some of the selected treatments were having slight increase in TPC at a decreasing rate. Therefore, Murunga leaf powder added samples have moderate effect on the reduction of microbes.

Table 6

Sensory evaluation sum of ranks for texture, odour and overall acceptance

Sensory Attribute	Control sample	T_1 Sample	T_2 sample	T_3 sample	T_4% sample
Color	53	66	54	75	75
Odor	60	76	63	58	49
Texture	66	71	63	79	76
Flavor	69	70	63	79	62
Overall acceptability	69	63	69	75	68

Disscussions. Citric acid was used for this study as per suggestion by [16] and found that coagulant has many effects on the prepared paneer cheese body and texture. A low level of acidic strength resulted in a smooth texture and soft texture of the body, while the high acidic strength resulted in a very hard body in the paneer. The paneer produced with curd yielded a smooth texture and a very soft texture because it is having lower acidic curd strength. The paneer cheese which was coagulated by citric acid showed a nearly a hard texture because of high acidic strength of citric acid. Chemical analysis of paneer samples were carried out by the method mentioned in the previous research articles [13]. The chemical composition of the Muringa-added hard paneer cheese is shown in Table 3.

Murunga leaf powder added to paneer was having consistency in protein and fat content. Also, the pieces of leaves provided nice color and appearance to the product. It increased consumer acceptance. They incorporate antioxidants compounds in to the food the improve 14]. Therefore, it is widely used in paneer to improve functionality.

Heat treatment especially pasteurization of milk destruct the microbes that denatures proteins available there and retards the solubility of colloidal form of calcium phosphate [4]. Total plate counts (TPC) and molds counts were tested and it was identified that TPC was having a significant difference with the control and the treatments ($P \leq 0.05$) and it increased drastically after 20 days of storage hence still it was recommended for consumption for 30 days.

It showed that Murunga leaf has a significant level of ($P \leq 0.05$) inhibitory effect on the bacteria. The molds were not observed throughout the experiments till 20^{th} day but there was a mold growth observed on the 30^{th} day. Also, it showed that Murunga leaf has a significant inhibitory effect on mold. It may be due to the hygienic conditions and the in-place cleaning mechanism maintained throughout the processing [15, 16].

Escherichia coli O157:H7 is recognized as a very important pathogen available [17]. Pathogens in food industry such as *E. coli* O157:H7 can survive in the acidic conditions and they can cause infections [18]. Studies about the Murunga leaves and its extracts revealed that the antimicrobial potential are available there and it inhibited the growth of 8 pathogenic bacteria such as *Streptococcus pyogenes, Escherichia coli, Staphylococcus aureus, Streptococcus agalactiae, Bacillus subtilis, Staphylococcus epidermis, Salmonella senftenberg*, and fungi such as *Candida albicans*). This suggests that the pharmaceutical industries and food processing industries can incorporate Murunga leaves and its extracts as a antimicrobial agent [19].

The sensory attributes that influence the acceptability of Murunga leaf powder added paneer such as color, odour, texture, flavour and overall acceptability are shown in Table 6. T_1 (0.50% Murunga leaf powder) showed the lowest level of overall acceptability score. The curd was pressed by using a spoon to evaluate the springiness and hardness [20]. Also, the T_4 sample showed a drastic increase in microbial count, the lowest level in odour and flavor. Murunga leaf has some essential oils which give more functional properties to paneer. Hexacosane, pentacosane and heptacosane are the essential oils found in the Murunga leaf extracts helps to improve the properties of paneer [22, 23].

However, overall acceptability and textural improvement were observed in T_3 sample which was significantly different ($P \leq 0.05$) and having the highest score for texture shown in figure 02. The analysis showed that the odour and overall acceptability of T_3 (1.50%

Murunga leaf powder) added sample showed the highest level of a score but a lower score for odour.

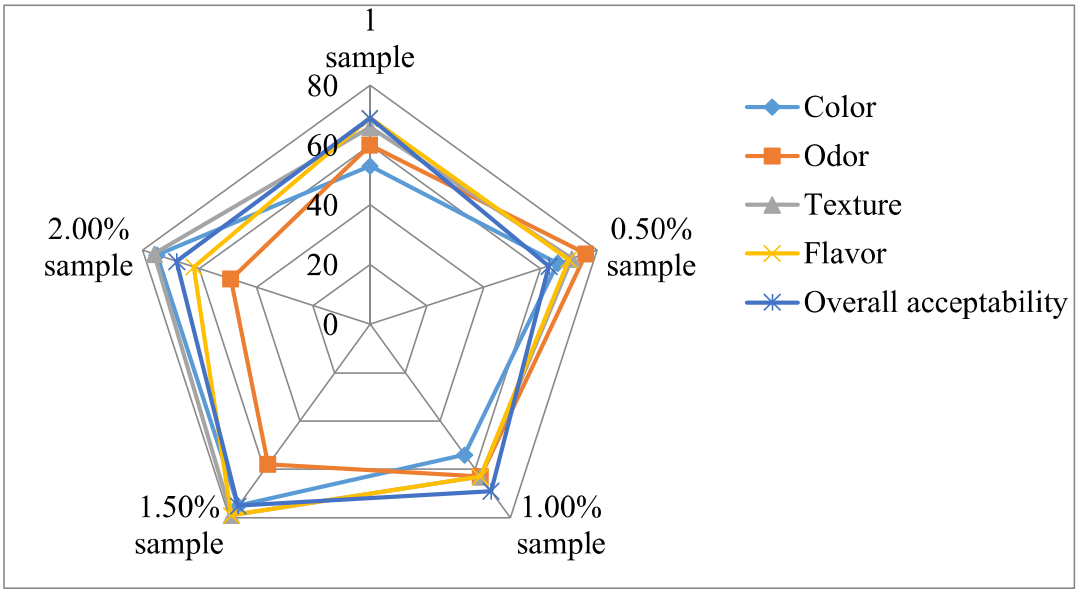

Figure 2. Sum of rank for Murunga leaf powder added sample and control sample

Figure 2 showed that the organoleptic properties of samples were having significant differences in color due to the natural pigments available in the Murunga leaf. Also, Murunga leaf powder is having some ability or compounds that may alter some attributes such as flavor, color, odor, appearance and overall acceptability. The juice produced from Murunga leaf has an antimicrobial agent and that inhibits the microorganisms such as *Staphylococcus aureus and Pseudomonas aeruginosa* [24]. The TPC of this study expressed a significant reduction of microbes Murunga leaf powder incorporated food compared to control with the storage time. It means the Spoilage of the Murunga leaf powder incorporated foods were slower than untreated samples.

Conclusion. Dehydrated Murunga leaf powder added to paneer has high acceptability especially T_3 is identified as the best percentage. Also, it has effects on increasing the shelf life of paneer due to the inhibitory effect against microorganisms. Therefore, Murunga leaf powder could be used as preservative agent in production of dairy products. Murunga leaf powder (1.5%) could be considered the acceptable amount for paneer cheese production.

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UDK 664.34:637.144

INDICATORS OF BLENDING OF REFINED VEGETABLE OILS

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Abstract:

Objective. This article discusses the issues of blending refined vegetable oils and the impact on fatty acid composition. The effect on its physicochemical properties has been studied.

Methods. The fatty acid composition was determined on an Agilent 8860 GC gas chromatograph with a flame ionization detector using a Supelco 100m x 0.25mm capillary column with SRtm-2560 phase, helium carrier gas, column programming temperature from 1400 C to 2500 C. The acid number and peroxide number were determined according to GOST standards.

Results. It has been established that biologically valuable components are higher in unrefined oil than in refined oil. The physicochemical composition of the resulting mixtures was studied, and it was found that they correspond to the normative technical documentation.

Conclusion. Thus, based on the study of blending refined vegetable oils at different ratios (as well as unrefined), the ratio of ω-6:ω-3 is different.

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