"Panampaniyaaram": A Traditional Food Product Made with Small-Millet for Revitalization towards Sustainable Nutrition

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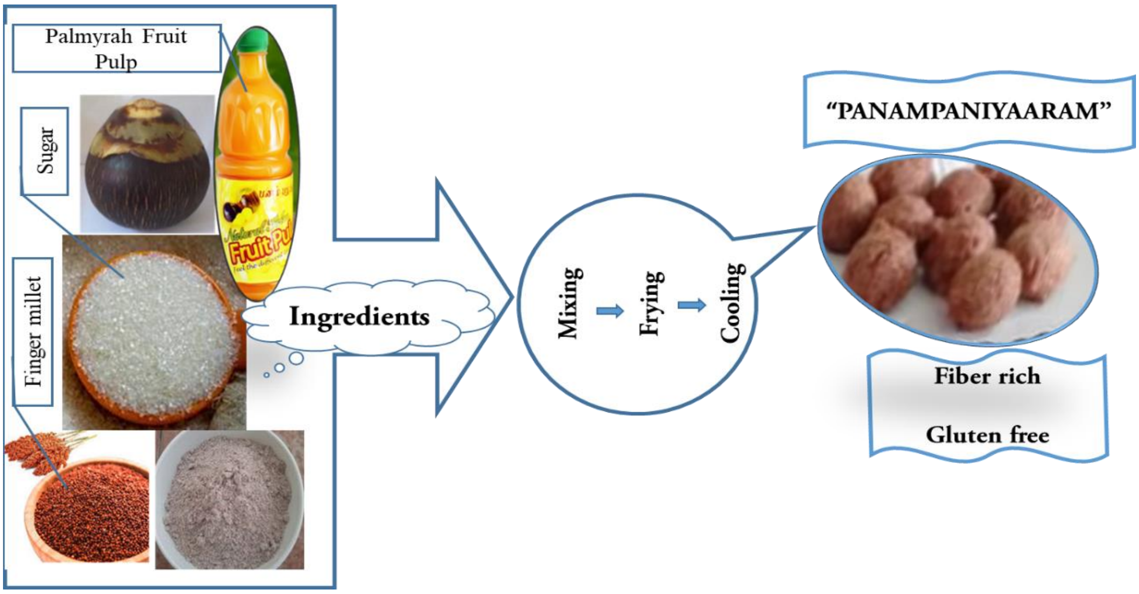

Abstract

The purpose of this research work was to increase the utilization of palmyrah fruit pulp and to obtain a nutritious diet that includes both palmyrah fruit pulp with small-millets by processing it into a value-added natural and traditional food product, "*panampaniyaaram*". Five series of sensory evaluations performed by panelists using a 9-point hedonic scale were used to assess nineteen treatments on different mixtures by altering the flour types and their percentages in four levels, with palmyrah pulp and small-millet flours, including finger millet, little millet, and Foxtail millet. The sample prepared from 100% finger millet flour was chosen as the most preferred sample, based on the results obtained from the sensory evaluations. Physicochemical analysis of the selected treatment revealed that pH was 5.86±0.01 and the total ash content 1.38±0.18 g/100 g was significantly ($p<0.05$) higher, and crude fat content 9.04±0.02 g/100 g, total salt content 0.201±0.026 g/100 g, and total sugar content 16.38 g/100 g, was significantly ($p<0.05$) less than that of the control sample which contained wheat flour. The selected treatment of the mineral content was significantly ($p<0.05$) higher than that of the control treatment and contained Calcium, Magnesium, Sodium, and Potassium were 150, 60, 32.7 and 76.8 mg/100 g, respectively. In summary, palmyrah fruit pulp and finger millet can be used to create healthy, nutritional and affordable natural snacks "panampaniyaaram", which will satisfy consumer preferences. Further studies are required to understand the developed product's organoleptic properties, antioxidant, vitamins, and anti-microbial activities as well as ways to extend its shelf-life.

Keywords: *Panampaniyaaram, palmyrah pulp, small-millets, finger millet, value-addition*

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1. Introduction

The Palmyrah (*Borasus flabellifer*) is named *Panai,* in Tamil and as *Tal* in Sinhala. It is also known as the '*Katpagatharu*' the wishing tree, because of its extraordinary capacity to produce a wide range of valuable natural and economical products. Almost every component of the palm tree is being used, even though the majority of items are still produced using traditional techniques. Palmyra trees are commonly grown in Southeast and South Asia. It is more prevalent in Sri Lanka's northern province, where 94.43% of the nation's Palmyrah trees are found, compared to 5.58% in the North-central, Eastern, and Southern Provinces (Jeyaweera, 1982, Sangeetha et al., 2014, PDB 2015).

Small millets are a set of minor crop cereals included in the Poaceae (also known as Gramineae) family, which is also called the grass family. Finger millet (*Eleusine coracana*), Little millet (*Panicum sumatrense*), Foxtail / Italian millet (*Setaria italica*), Barnyard millet (*Echinochloa frumentacea*), Proso millet (*Panicum miliaceum*), Pearl millet (*Pennisetum glaucum*) and Kodo millet (*Paspalum scrobiculatum*) are the significant small millets available worldwide.

Due to the abundance of Palmyrah trees in Northern Province and Jaffna, people in these areas have easy access to Palmyra fruit. Both children and adults enjoy *panampaniyaaram*, which is traditionally prepared by adding Palmyra fruit pulp, wheat flour, and sugar. It provides the body with vitamin A, C, calcium and phosphorus and functions as a laxative when consumed (Jeyaweera 1982, Jana and Jena 2017, Vengaiah et al., 2015).

These days, millets and small millets are becoming more popular due to their high nutritional content and other advantages, such as antioxidant activities, high fiber content and low glycemic indexes (Bhat et al., 2018, Paschapur etal., 2015, Ravinder singh et al., 2015). Thus, following a suggestion from the Indian government, the United Nations has stated 2023 as the "International Year of Millets."

The International Year was declared with the objectives of increasing public awareness of the importance of millets for diet security and nutrition, motivating small industrialists to improve sustainable production and value of millets, and increasing involvement and investment in research and development and extended services to accomplish the two goals. In order to promote millets and small millets as an essential component in the food basket, this offers a special opportunity to boost worldwide production, provide effective management and usage as well as encourage improved access among food systems.

Therefore, the objective of this research was the development and physicochemical analysis of *'Panampaniyaaram'*, incorporated with small millets.

2. Materials and methodology

2.1 *Materials*

2.1.1 *Material Collection*

The primary component preserved Palmyrah fruit pulp bottle was acquired from the Palmyrah Development Board, production unit. Finger millet and little millet were bought from local farmers in the Jaffna peninsula and was polished and ground into flour. Italian millet flour was purchased from a local drugstore in Jaffna. Other additional constituents such as wheat flour, sugar, and coconut oil were gathered from the marketplaces in Jaffna. All the collected materials were stored at room temperature in air sealed packs. Studies under this research were conducted at Palmyrah Research Institute, Kaithady, Jaffna.

2.1.2 *Reagents*

Petroleum ether, 5% Sodium Hydroxide (NaOH), Hydrochloric acid (HCl), Ethanol, Concentrated HNO_3 (Nitric Acid), Potassium hydroxide (KOH), Potassium cyanide (KCN),

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Concentrated ammonium hydroxide ($NH_{4\text{gure}}$ OH), Ethylenediaminetetraacetic acid (EDTA) Solution, pH 10 Ammonia - Ammonium chloride buffer solution, K_2CrO_4 (Potassium chromate), 0.1M $AgNO_3$ (Silver nitrate), Distilled water, Fehling's Solution I, Fehling's Solution II, Patton and Readers indicator, Eriochrome black T indicator, and Methyl blue indicator.

2.1.3 *Equipment / Apparatus*

Analytical balance, hot air oven, muffle furnace, Soxhlet apparatus, gas cooker, fume cupboard, thermostatic water bath, flame photometer, Thermo scientific pH meter, digital refractometer, Bunsen burner, desiccators, petri dishes, crucibles, fat thimbles, mortar and pestle, round bottom flasks, conical flasks, volumetric flasks, pipettes, micro pipettes, burette, beakers, test tubes, test tube holders, funnels, filter papers, pH paper, cotton wool, and spoons.

Software Minitab 17 was used as the statistical analysis software tool to analyze the collected data statistically and data collection and computation were done using Microsoft Excel 2018.

2.2 ***Methodology***

2.2.1 *Formulation of the Products*

Statistical Design for the preparation of the products was generated altering the flour types of flour and their percentages in four levels, a total of nineteen treatments were developed, including the control treatment; using the statistical analysis software Minitab 17.

Initially, the palmyrah fruit pulp: flour: sugar was measured in the ratio of 1:1:0.5 and poured in to a bowl and then stirred well until the mixture obtains a non-sticky consistency (Figure 1). Then, small, rounded portions of the created batter were added into the frying pan containing heated coconut oil and were golden fried.

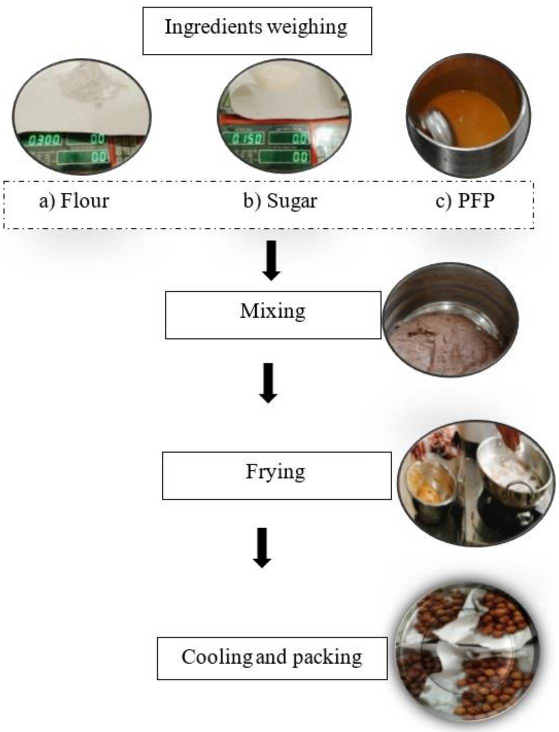

Figure 1. Process of making *Panampaniyaaram* incorporated with small-millets

2.2.2 *Selection of the most preferable treatment*

Sensory evaluations were performed on the immediate day after production due to its short (3 days) shelf life, by 30 panelists, in order to select the most preferred treatment which contain the

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different percentages of specific flour. Standard ballot sheets were provided to each panelist who were then required to rank the coded samples according to the characteristics of taste, appearance, aroma, color, texture and overall acceptability using the 9-Point Hedonic Scale. The best treatment was selected from the four sets of sensory evaluation considering, specifically, the overall acceptability characteristics (Figure 2). Finally, the fifth sensory evaluation was performed to select which of the four treatments (Chosen samples from four earlier sensory evaluations) was the most preferred choice.

Figure 2. Sensory Evaluation of the product

2.2.3 Determination of Physical, Chemical and Nutritional Analysis

Laboratory experiments were conducted to determine the physical, chemical and nutritional characteristics of 'Panampaniyaaram' which was prepared from small millets (selected treatment) and 100% wheat flour (control treatment) without adding preservatives.

Homogenized samples (10 g) were taken in a 50 mL clean glass beaker and left for a few minutes after which the solutions were filtered by using separate filter papers. Thereafter, their pH was measured by using a digital pH meter (Sension PH 31-Spain) at room temperature (28±2 °C). The pH meter was calibrated with the standard buffers of pH 4, 7, and 10. Then the electrode was rinsed and immersed in the sample and the measurement was taken.

Moisture content (Oven Dry Method, AOAC 2019), Ash Content by incineration method AOAC 2019), Crude Fat content (Soxhlet Extraction method), Total Salt Content (Korkmaz, 2001) and Total Sugar Content (Lane - Eynon Method) were determined. Sodium, potassium and calcium, magnesium were determined by using flame photometry method and E.D.T.A titration method (Vogel, 1989) respectively.

2.3 *Statistical analysis*

Sensory evaluation data was statistically analyzed using the Friedman non-parametric method and the physicochemical results obtained from selected and control samples with three replicates were subjected to complete randomized design (CRD) for the analysis of variance. Turkey comparison was used in Least Significant Difference (LSD) at 5 % level, to analyze the significant difference among the samples by using Minitab 19 software.

3. Results and discussion

3.1 *Sensory analysis*

The results were statistically analyzed using Minitab 17 a non-parametric statistical analysis. Based on the Friedman Test results as considering the Median values and Sum of ranks; the highest scores for the parameter of overall acceptability were showed to Sample Code of 103, 110, 112 and 119 respectively in the 1, 2, 3 and 4 sensory evaluations (Figure 3). Finally, from the sensory evaluation

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5 Sample Code 121 (Treatment 2) was selected as most preferable treatment which is formulated with 100% Finger Millet flour (Table 1). As shown by the results, the products were showed significant difference between (P< 0.05) the samples for the parameters of taste, aroma and overall acceptability while, there were no significant difference (P > 0.05) for the parameter appearance, texture and colour. Physio - chemical, nutritional and minerals were analyzed for the most preferred sample (Treatment 2) selected from the sensory analyses was produced using 100% finger millet flour and the Control (Treatment 1) sample was prepared by adding 100% wheat flour.

Table 1. Median values of overall acceptability for the each set of sensory evaluations

Sensory evaluation set	Sample Code	Flour type combination	Median values of overall acceptability
1	101	100% Wheat flour	8.0
	102	100% Italian Millet flour	7.0
	103	100% Finger Millet flour	8.0
	104	100% Little Millet flour	7.0
2	105	50% Wheat flour and 50% Italian Millet flour	6.6
	106	50% Wheat flour and 50% Little Millet flour	6.5
	107	50% Italian flour and 50% Little Millet flour	6.5
	108	50% Wheat flour and 50% Finger Millet flour	7.3
	109	50% Little flour and 50% Finger Millet flour	6.5
	110	50% Italian flour and 50% Finger Millet flour	7.5
3	111	33.33% Wheat flour + 33.33% Finger Millet flour + 33.33% Little Millet flour	6.2
	112	33.33% Wheat flour + 33.33% Finger Millet flour + 33.33% Italian Millet flour	7.7
	113	33.33% Wheat flour + 33.33% Little Millet flour + 33.33% Italian Millet flour	6.5
	114	33.33% Finger Millet flour + 33.33% Italian Millet flour + 33.33% Little Millet flour	6.5
4	115	62.5% Wheat flour + 12.5% Finger Millet flour + 12.5% Little Millet flour + 12.5% Italian Millet flour	7.0
	116	62.5% Wheat flour + 12.5% Finger Millet flour + 12.5% Little Millet flour + 12.5% Italian Millet flour,	6.0
	117	62.5% Wheat flour + 12.5% Finger Millet flour + 12.5% Little Millet flour + 12.5% Italian Millet flour,	6.0
	118	62.5% Wheat flour + 12.5% Finger Millet flour + 12.5% Little Millet flour + 12.5% Italian Millet flour,	5.8
	119	25% Wheat flour + 25% Finger Millet flour + 25% Little Millet flour + 25% Italian Millet flour	7.2
5	120	25% Wheat flour + 25% Finger Millet flour + 25% Little Millet flour + 25% Italian Millet flour	6.5
	121	100% Finger Millet flour	8.5
	122	50% Italian flour and 50% Finger Millet flour	6.5
	123	33.33% Wheat flour + 33.33% Finger Millet flour + 33.33% Italian Millet flour	7.5

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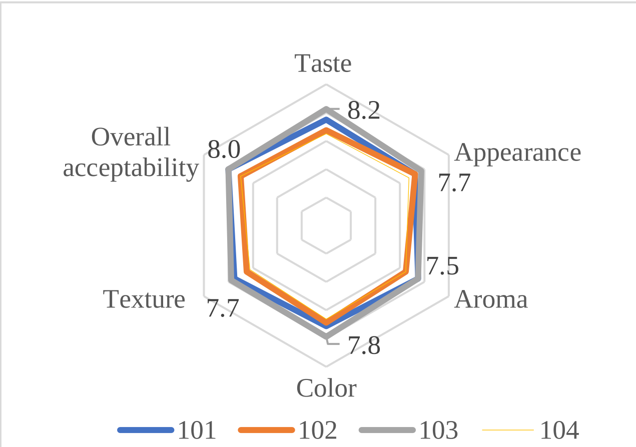
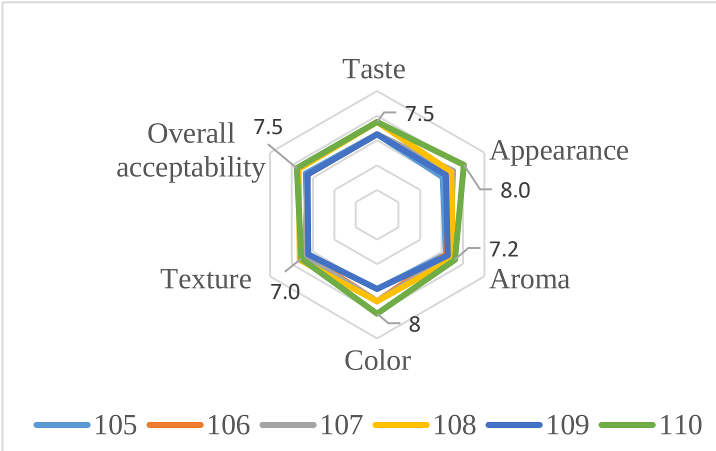
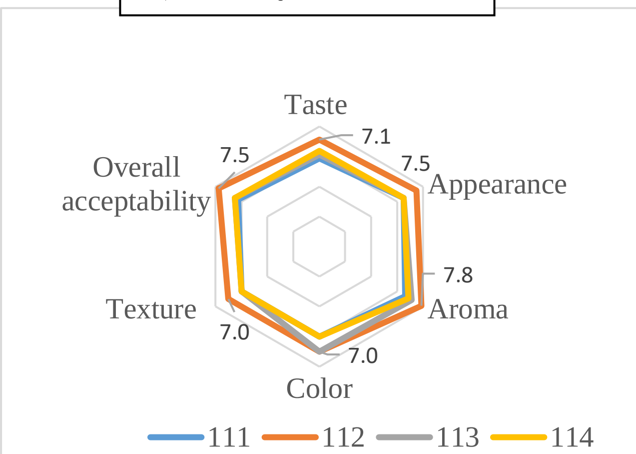


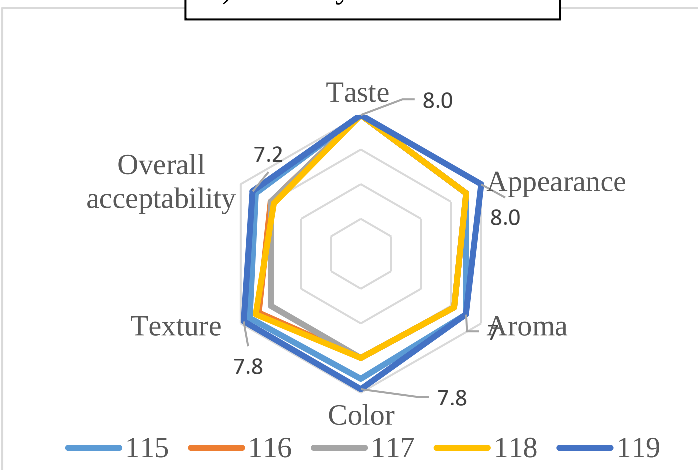
a). Sensory Evaluation 1



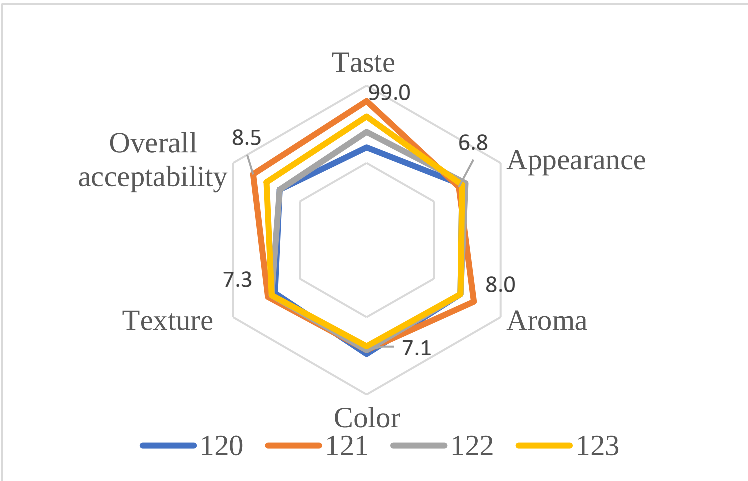
b). Sensory Evaluation 2



c). Sensory Evaluation 3



d). Sensory Evaluation 4



e). Sensory Evaluation 5

Figure 3. Radar chart of the sensory parameters and their Median values of selected treatment with sample code

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3.2 *Physio - Chemical results analysis*

A digital pH meter was used to determine the pH value. The pH of the control sample (5.54±0.02) is lower than that of the selected treatment 2 sample (5.86±0.01), resulting in it being more acidic and containing more free H^+ ions. The products might be seen as slightly acidic because of the additives and preservatives that have been added to processed palmyrah pulp. A higher pH in the finger millet sample also suggests the presence of alkaloids that possess antioxidant, anti-inflammatory, anti-mutagenic, and anti-carcinogenic characteristics (Lamponi et al., 2021). Proximate analyses as moisture content, total ash content, crude fat content and total sugar content and also salt content were carried out.

The moisture content (%) indicates that the treatment 2 sample (15.2±3.2%) has a lower moisture content than the control sample (20.3±0.9). Moisture content, or the percentage of water in food, is an essential aspect of the quality of food and storage. Lower moisture content enhances the preservation of food for a longer time while preserving its chemical and physical qualities (Nielsen 2010, Nirmaan 2020, Afify et al., 2017).

Ash content is a nutritional indicator of mineral content. According to total ash content, in comparison to the control sample (0.75±0.08g/100g), the treatment 2 sample (1.38±0.18g/100g) had more (Table 2). A food's ash content, which represents the overall amount of minerals it comprises, suggests that the type and concentration of minerals it contains impacts its quality. The physicochemical characteristics of food can be affected by high mineral concentrations, which can also be employed to inhibit the growth of specific microbes. Minerals are vital for a nutritious diet (Afify et al., 2017, Ismil 2017).

Table 2. Physicochemical analysis of the Control and Treatment 2 samples

Analysis	Control	Treatment 2
Moisture Content (%)	15.2±(3.2)^a	20.3±(0.9)^a
Total Ash Content (g/100g)	0.75±(0.08)^b	1.38±(0.18)^a
Crude Fat Content (g/100g)	17.95±(0.02)^a	9.04±(0.02)^b
pH	5.54±(0.02)^b	5.86±(0.01)^a
Total Sugar Content (g/100g)	18.15± (0.04)^a	16.38±(0.05)^b
Total Salt Content (g/100g)	0.259±(0.052)^a	0.201±(0.026)^b

Each value in the table is represented as mean ± SD (n = 3). Values in the same rows followed by a different letter (a, b) are significantly different ($p < 0.05$).

The overall quantity of fat included in a food is referred to as crude fat. According to crude fat data analysis, the control sample (17.95±0.02 g/100 g) was higher than that of the treatment 2 sample (9.04±0.02 g/100 g). Crude fat helps the body transport and absorb vitamins that are fat-soluble and it also serves as a major source of energy. Despite the fact that fat is a necessary source of fatty acids and energy, eating too much of it can lead to health problems which includes heart diseases and obesity. Therefore, it is essential to recognize the crude fat content of food, both for health and dietary nutritional reasons. In accordance with the Food Act 2019 regulations, these food labels with the crude fat content readings of the control sample will be presented in red, as it is greater than 17.5 g; while treatment 2, will be displayed in amber, as it is between 3 g and 17.5 g.

The results of the Treatment 2 sample contain lesser amount of both total salt and total sugar content than the control sample. Typically, salt and sugar are only used to flavor and sweeten meals. The beneficial effects of limiting salt intake include preventing iodine shortage, oral rehydration, improved cardiovascular health, and prevention of hyponatremia. Reducing sugar consumption has

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benefits for improving skin problems, low blood pressure, and providing an instant boost of energy (Gupta et al., 2018). High salt consumption has been linked to a higher risk of fatty liver disease, obesity and metabolic syndromes. High sugar intake is also indirectly linked to an increased chance of type II diabetes (Gupta et al., 2018).

Consumption of salt and sugar is directly linked to elevated levels of endothelial dysfunction, systemic and hypothalamic inflammation, microangiopathy, cardiovascular remodeling, malignancies, and even death (Gupta et al., 2018). In general, it can be said that eating too much salt and sugar increases the risk of non-communicable diseases. Therefore, consuming treatment 2 for a snack instead of eating the control lowers the risk of contracting the previously mentioned diseases.

The total sugar content of the control (18.15 g/100 g) and treatment 2 (16.38 g/100 g), both of which range between 5 g and 22 g are displayed on the food label with an amber color code. Similarly, the total salt content of the control (0.259 g/100 g) will be presented in amber, as it is between 0.25 g and 1.25 g, and salt content of treatment 2 (0.201 g/100 g) will be displayed in green, as it is less than 0.25 g in accordance with the Food Act 2019 guidelines.

3.3 *Minerals analysis*

The results of the minerals analysis show that, the treatment 2 sample had significantly higher mineral levels of all the measured minerals calcium, magnesium, sodium and potassium than the control sample in the analysis (Table 3). Minerals are essential elements that our bodies require in small quantities for proper function, good health, and development. Calcium, phosphorous, magnesium, sodium, potassium, and rron are minerals that reduce blood sugar by activating the insulin receptor. Sodium and magnesium prevent cardiovascular disorders by maintain the water balance. Magnesium is a mineral that relieves constipation; while sodium, magnesium, potassium and calcium are used for pressure management. Potassium (for removing wastes), magnesium (for preventing constipation), and calcium (for preventing diarrhea) are minerals that aid digestion. Calcium helps lower LDL cholesterol by reducing body fat, and magnesium helps the body balance sugar so that blood glucose can be converted into energy. Magnesium, potassium and sodium minerals control temperature via controlling water absorption. Calcium and magnesium are two minerals that are used to transmit messaging signals and stimulate the neurological system (Murakami 2007, Eilat Adar 2013, Dubey 2020).

Table 3. Minerals analysis of the Control and Treatment 2 samples

Minerals (mg/100g)	Control	Treatment 2
Calcium	15[b]	150[a]
Magnesium	30[b]	60[a]
Sodium	19.75[b]	32.7[a]
Potassium	34.6[b]	76.8[a]

Each value in the table is represented as mean ± SD (n = 3). Values in the same rows followed by a different letter (a, b) are significantly different ($p < 0.05$).

Small millets are complex carbohydrate used to cure conditions including diabetes, cardiovascular diseases, gastrointestinal issues like constipation, diarrhea, and improve digestion and bowel movements, as well as ailments like diabetes, wound healing, and to regulate body weight. They also help control body temperature and blood pressure.

Finger millet, which is a small-millet, is only used in treatment 2, whereas wheat flour was used exclusively in the control. Therefore, the probability of getting the illnesses mentioned above is

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minimized by using treatment 2 as a gluten-free snack with palmyrah fruit pulp, when compared to the control sample.

4. Conclusions

'*Panampaniyaaram*', incorporated with finger millet flour will promote a healthy lifestyle than traditional snacks with wheat four as an ingredient and enhance the national population's access to affordable, natural, high-quality, and cost-effective food. Additionally, it can benefit those of all ages who consume it, as well as those with medical conditions including prediabetes mellitus.

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Declaration of interests

The authors have no potential conflicts of interest to report.

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