

**SPECIMEN FORMAT FOR THESES OF MONTH**

<b>Faculty</b>	:	School of Home Science
<b>Department</b>	:	Food Science and Nutrition
<b>Branch/ Area:</b>	:	Food Science and Nutrition
<b>Sub Subject Heading:</b>	:	Edible Food Packaging
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<b>Title of the thesis</b>	:	Sustainable Solutions: Edible Millet Tableware as a Substitute for Single-Use Cutleries in the Food Service Sector
(i) In Roman Script  (ii) In roman Script		(i) SUSTAINABLE SOLUTIONS: EDIBLE MILLET TABLEWARE AS A SUBSTITUTE FOR SINGLE-USE CUTLERIES IN THE FOOD SERVICE SECTOR  (ii) Sustainable Solutions: Edible Millet Tableware as a Substitute for Single-Use Cutleries in the Food Service Sector
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<b>Designation of Supervisor</b>	:	Professor
<b>Centre/department/school in which research was conducted</b>	:	Department of Food Science and Nutrition / School of Home Science
<b>University's Name &amp; Address</b>	:	Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore - 641043

**Abstract within 300 words:**

The widespread utilization of single-use plastics, driven by its convenience and low cost in food packaging has fostered a throwaway culture that possess significant environmental risk on biodiversity. The present study aims to develop edible tableware from millets (Pearl millet and Sorghum) as a sustainable alternative to single-use plastic cutlery. The millet tableware is functionally enhanced by germinating and roasting the millets and enriched with antioxidant-rich flower powder (Hibiscus and Rose). The physical, technological, and nutritional properties of pearl millet and sorghum grains were assessed. Germinating the millets improved flour yield and reduced antinutritional factors, while roasting enhanced water and oil absorption, reduced moisture content, and increased total phenolic content. Functional properties indicated that processing millets reduced crystallinity of millet flour. Roasted pearl millet tableware exhibited higher nutrient content, particularly in fiber, iron, and phosphorus, while sorghum tableware excelled in carbohydrates, protein, and calcium. Roasted tableware also showed an improved textural property, whereas germinated millet tableware demonstrated reduced hardness and water absorption rate. Drop test revealed that roasted tableware had higher resilience than its germinated counterparts. The flower-enriched millet tableware exhibited enhanced antioxidant properties. Roasting and flower enrichment significantly improved the nutritional profile, particularly carbohydrate, protein, fiber, and iron content. The enrichment also introduced distinct sensory attributes, with high consumer acceptance in the liked moderately and liked very much categories of nine-point hedonic scale. The flower-enriched cup and spoon maintained its structural integrity upto 20 minutes, while bowl, katori and plate hold upto 30 minutes at cold and hot temperature without water absorption and the tableware remained intact upto 60 minutes at cold temperature that suits for serving hot and cold food and beverages. It exhibited minimal microbial load and weight gain over the storage period of 120 days. Brine shrimp lethality assay confirmed millet tableware as safe to consume with a mortality rate of 10 per cent due to bioactive compounds. It degraded completely within 12 days in wet topsoil. The present study demonstrates the potential of millet tableware, especially roasted and flower-enriched variants, as sustainable, biodegradable, and functional alternatives to single-use cutlery. It provides an eco-friendly solution for culinary and packaging applications that can be utilized in food service sector including hospitality, entertainment, catering and food courts.

**Key words:** *sorghum, pearl millet, edible flower, single-use cutlery, millet tableware, biodegradability*

## **i) Major objectives :**

### **Primary Objectives**

The primary objectives of the present study include,

- To analyze the properties of pearl millet and sorghum in unprocessed, germinated and roasted forms.
- To formulate and standardise millet tableware including cup, bowl, katori, spoon and plate using unique molds.
- To enrich the standardised millet tableware with selected flower powder to serve food and beverages at ambient, hot and cold temperature in the food service sector.

### **Secondary Objectives**

The secondary objectives of the present study include,

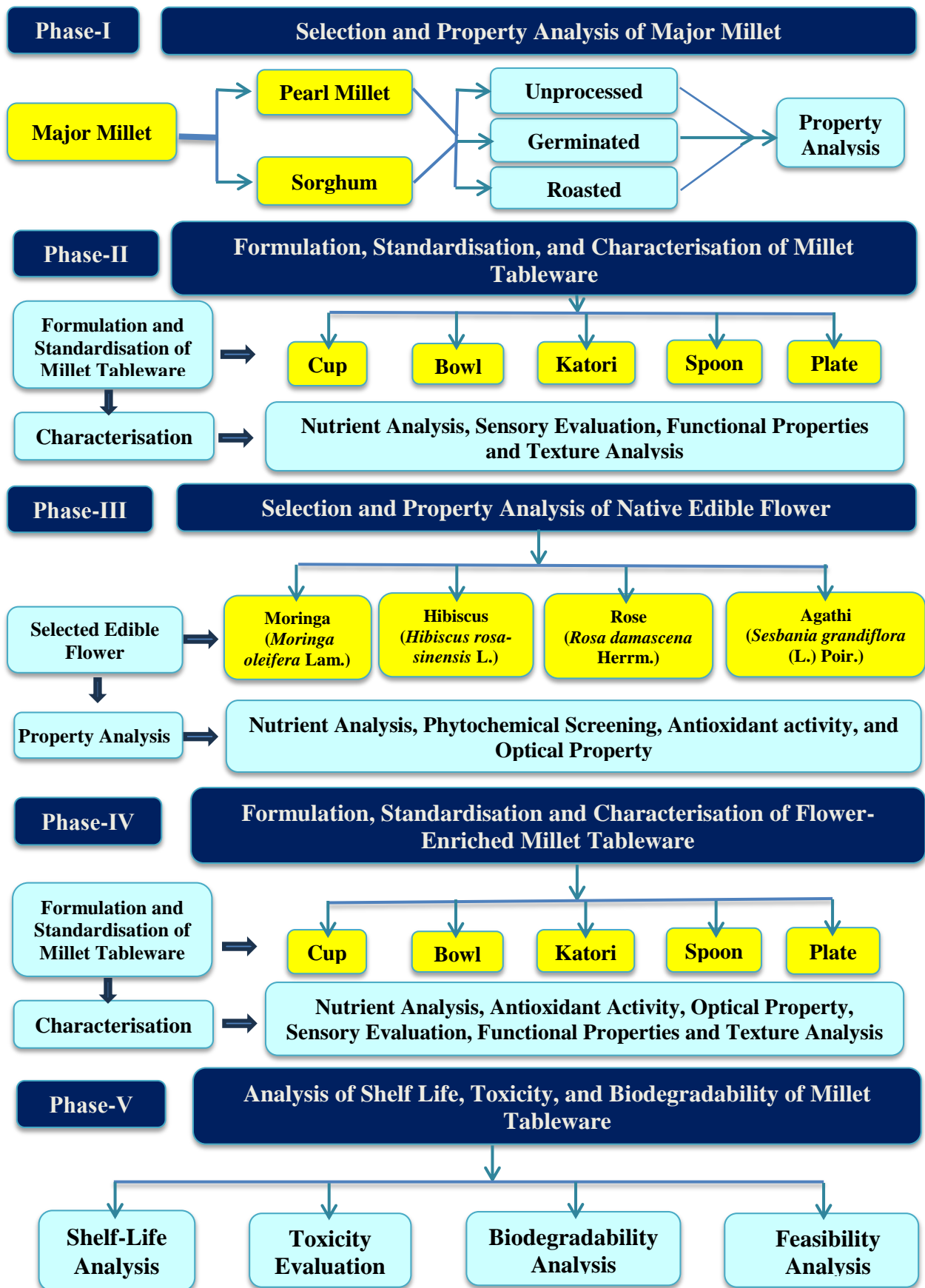
- Identification and selection of major millets and native edible flowers.
- Formulation, standardisation and characterisation of millets tableware.
- Incorporation of selected flower powder and characterisation of standardised flower-enriched millet tableware.
- Shelf-life, toxicity and degradability analysis of the standardised flower-enriched millet tableware.

## **ii) Hypothesis:**

The research hypotheses of the present study are as follows,

- i. The standardisation of edible millet-based tableware from pearl millet and sorghum that is enhanced by conventional processing techniques (germination, roasting) and enriched with antioxidant-rich flower powder provides a sustainable, eco-friendly, and functional alternative to single-use cutleries in the food service sector.
- ii. Incorporating antioxidant-rich native flowers improves the sensory, and mechanical properties of millet tableware, making it suitable for practical use in the food service industry.

iii) Methodology :



#### **iv) Findings:**

The characterisation of standardised flower-enriched millet tableware involves a multifaceted evaluation, including nutrient composition, functional properties, texture analysis and consumer acceptability. The results of the property analysis highlighted the potential of millet tableware as a sustainable alternative to single-use plastics, offering both functional properties and health benefits due to the inclusion of antioxidant-rich flower powder. The characterisation ensured that the tableware is not only eco-friendly but also meets the sensory and structural integrity for its practical use in food service applications.

The physical, technological, and nutritional properties of pearl millet and sorghum grains, emphasized the impact of processing methods such as germination and roasting. Sorghum grains are larger and thicker than pearl millet, with higher weight and volume, while pearl millet exhibited a higher length-to-breadth ratio. Germination enhanced flour yield and reduced antinutritional factors, such as phytic acid and tannin. Roasted millets exhibited improved water and oil absorption capacity, decreased moisture content, and enhanced total phenolic content. Functional properties revealed that germination reduced crystallinity and disrupts molecular organization, whereas roasting promoted molecular packing in millet flour.

The millet tableware standardised from pearl millet and sorghum, focused on the effects of processed (roasting, germination) and unprocessed variants, on its nutrient profile, functional properties and texture analysis. Roasted pearl millet tableware exhibited highest nutrient content, especially fiber, iron and phosphorous content, while sorghum tableware excelled in carbohydrate, protein and calcium content. Sensory evaluation of millet tableware was between moderately liked to liked extremely category. Roasting enhanced texture analysis, whereas its germinated counterparts showed reduced hardness and break force and elasticity but increased water absorption rate. Water absorption rate demonstrated that all the tableware absorbed water at initial phase and exhibited a reduced absorption after 30 minutes of exposure. FTIR and TGA analyses revealed compositional and thermal stability differences, with roasted tableware exhibited complete thermal degradation. Drop tests further confirmed the highest resilience of roasted tableware as compared to its germinated counterparts. Roasted millet tableware emerged as an optimal formulation due to its nutrient density, and better texture analysis, making it as a sustainable alternative to single-use plastics. Germinated tableware was excluded from further development due to its decreased texture properties.

Four edible flowers (Agathi, Moringa, Hibiscus and Rose) were selected, and it has good quantity of micronutrients. Phytochemical screening of selected edible flowers confirmed the presence of bioactive compounds. Strong antioxidant activity was found in hibiscus and rose flower powder and its enrichment in millet tableware enhanced the optical and functional properties.

The characterisation of flower-enriched millet tableware highlighted the impact of roasted millet and flower enrichment (hibiscus and rose) on its nutritional, sensory, and functional and texture properties. Roasting and flower enrichment significantly improved the nutritional profile, boosting carbohydrates, protein, fiber, and iron, with hibiscus-enriched variants excelled in fiber and antioxidant activity. Roasting of millets enhanced visual appeal, crispiness, and consumer acceptability, while flower enrichment introduced unique sensory attributes and high consumer acceptance was noted in roasted variants. FTIR and TGA revealed molecular and thermal changes, and flower powder enrichment contributed distinct functional groups and roasted tableware exhibited highest thermal degradation. Roasted tableware exhibits superior impact resistance, water retention, and texture analysis compared to its unprocessed and flower-enriched counterparts. Roasted millet flower-enriched tableware exhibited as the nutrient rich variants with better sensory scores and enhanced texture properties that emerged as a sustainable alternative for diverse culinary applications and a sustainable eco-friendly innovation. Shelf life analysis showed that roasted and flower-enriched tableware exhibited lowest microbial load as compared to its unprocessed counterparts. Change in weight exhibited that the tableware showed a minimal weight gain due to moisture absorption and roasted variants exhibited lowest weight gain indicating better moisture resistance. Cytotoxicity tests confirmed ten percentage of mortality due to the presence of phenolic content but within safe limits. All the tableware was degraded within 12 days in wet top soil. Cost analysis highlighted the affordability of the millet tableware, with slight cost increases for processing and flower enrichment. The flower-enriched millet tableware standardised in the present study is a promising solution to replace and reduce single-use cutlery in food service sector. Its nutritional profile with enhanced functional properties and biodegradability defines as a sustainable and viable solution for diverse culinary applications.

## **Examiners**

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