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Development of Ready to Cook Kadubu Mix and Evaluation of its Anti-Diabetic and Anti-Inflammatory Potential

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Abstract

There is a growing demand for healthy and nutritious foods among consumers. India's famous golden grain is gaining popularity and evolving into a nutrient-dense, naturally gluten-free, Diabetes and heart disease-fighting food. Consumers are towards making this super grain a habit. Millets are promoted as, smart crop beneficial to the farmers and environment friendly. They are highly tolerant to high temperatures, frequent droughts and floods. Millets are also called nutricereals, they are highly nutritious, improve gut health and immunity with other health benefits. Millets are essential food to include in the diet across all age groups: infants, toddlers, teenagers, adolescents, adults, pregnant women, lactating mothers, and elderly people and in therapeutic diets. They are used as a traditional staple food in dry land regions all over the world. They are gaining popularity as a food based strategy to overcome non-communicable diseases. Millets are versatile grains which can be consumed in various forms such as main meals, snacks, desserts. Kadubu is a steamed dumpling dish, popularly used as breakfast /snack in various regions of Karnataka. This study aims to develop a ready-to-cook kadubu mix using millets (Bajra and Sorghum) and Green gram as main ingredients. The functional herb *Centella asiatica* (Brahmi leaves, a memory booster) and a good source of micronutrients, phytochemicals and antioxidants were incorporated into the ready-to-cook kadubu mix. These selected ingredients create a tasty, nutritious, indigenous traditional steamed dish, with health benefits. Three different variations of ready to cook kadubu mix (V1, V2, and V3) were developed, along with Regular kadubu mix (Basic) made with broken white rice and dry coconut. Further, three variations of steamed Kadubu (v1, v2 and v3), and kadubu (basic) were prepared and subjected to sensory evaluation using a 9-point hedonic rating scale by 40 semi-trained panelists. Results of sensory evaluation showed that kadubu (v3); prepared from ready to cook Kadubu mix (V3) , was best accepted among the three variations. The best-accepted and best-rated steamed kadubu (v3) was evaluated for nutrient content, micronutrient analysis, phytochemical screening, anti-diabetic activity, anti-inflammatory activity, and shelf life. This study shows that by incorporating millets, whole grams, Brahmi leaves, nuts, and oil seeds, the nutritional value of ready-to-cook kadubu mix can be considerably enhanced.

Keywords: Millets, Green gram, *Centella asiatica* (Brahmi leaves), Ready-to-cook Kadubu mix, Sensory evaluation, Phytochemical screening, Anti-diabetic activity, Anti-inflammatory activity.

1. Introduction

Kadubu is a traditional Indian steamed dumpling popular in southern states, especially Karnataka. This dish can be made with or without fillings. Kadubu with fillings is generally sweet or savory; round or semicircle shaped. This traditional dish is made with rice, lentils, vegetables, coconut, jackfruit, sesame seeds, groundnuts and jaggery/sugar. The main component of kadubu is rice flour, which is kneaded with water to create soft dough. Fillings often include a mixture of grated coconut and jaggery, sometimes flavored with cardamom. The preparation involves shaping the dough around the filling and steaming it until soft. This steaming method preserves the nutritional value and enhances the flavors.

Kadubu is enjoyed not only during festivals, but on special occasions, depicting the rich culinary heritage of the region. Kadubu preparation holds significant cultural value in many South Indian households, often prepared during festivals such as Ganesh Chaturthi. It is associated with various rituals and is a symbol of prosperity. The dish is symbolic of the culinary traditions of the region, conveying the use of locally grown ingredients and traditional healthy cooking methods passed down through generations.

The importance of the interplay between inflammation and nutrition has generated much interest in recent times. Inflammation has been identified as a key driver of disease-related malnutrition, leading to anorexia, reduced food intake, muscle catabolism, and insulin resistance, which leading to a catabolic state.

Diabetes mellitus (DM) is a metabolic disorder characterised by abnormal glucose, protein and lipid metabolism, resulting in an elevated plasma glucose level. Plant based foods with promising therapeutic potential and lesser adverse effects are gaining attention for Diabetes control. Pharmaceutical antidiabetic medicines, though effective, may have side effects. Plant-based foods do not have these side effects and do not require a strict regimen because they can be consumed as food. Dietary changes will reduce the intake of anti-diabetic drugs and the individual can enjoy traditional festival foods, along with other family members. This research study was carried out to develop a ready-to-cook Kadubu mix using millets, green gram, Brahmi leaves, sesame seeds and groundnuts. White rice based Kadubu (Basic) and Millets based Kadubu (3 variations) were prepared. Nutritional composition, sensory evaluation, assessment of anti-diabetic and anti-inflammatory potential of the developed and best rated millet based Kadubu was carried out.

2. Materials and Methods

Table 1: Selection and procurement of equipment and good quality raw ingredients for preparation of Ready to cook Kadubu mix and steamed Kadubu (basic and variations)

	Description
Equipments	Stainless steel steamer with trays.
Ingredients procurement	Good quality raw ingredients - White Rice, Dry coconut, Bajra, Sorghum, Green gram, Brahmi leaves, Sesame seeds, Groundnuts, Coriander seeds, Jeera whole, Dry red chilli, Dry pepper, Curry leaves, Ghee, and salt - were selected and procured locally.
Visual inspection of grains (Millets and Green gram)	Grains were examined for the presence of any undesirable non-food substances. Good quality grains based on colour, size, shape, and overall quality were selected and procured locally.
Hygienic and Sanitary procedures followed in Pre-preparation, Preparation, Packaging, Storage Steaming and Serving	Clean potable drinking water was used in the preparation of Kadubu (basic and variations). Weighing ingredients accurately, Cleaning, Sprouting, Roasting, Milling and Steaming were carried out following good sanitary practices in the Food and Nutrition laboratory of the college.

Figure 1: Major Ingredients required for Preparation of Ready-to-cook Kadubu mix (3 Variations)

Bajra (*Pennisetum glaucum*)

Sorghum (*Sorghum bicolor*)

Greengram (*Vigna radiata*)

Brahmi (*Centella asiatica)*

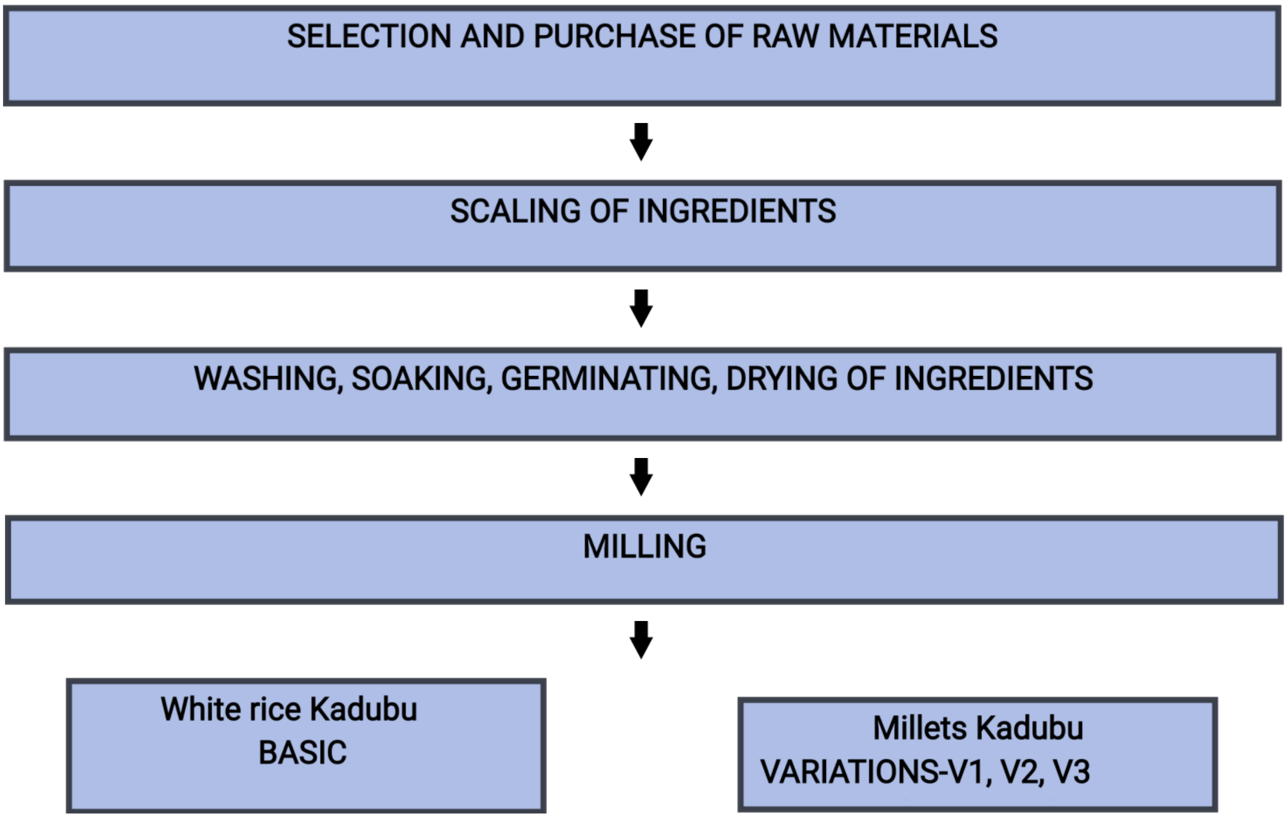


Figure 2: Preparation of Ready to Cook Kadubu Mix

FRESH RAW BRAHMI LEAVES (100g) , CLEANED

↓

SHADE DRIED FOR 4 DAYS AT ROOM TEMPERATURE (26^{U}C)

↓

BRAHMI LEAVES POWDERED USING A BLENDER

↓

BRAHMI LEAVES POWDER (17g), STORED IN AIRTIGHT CONTAINER

Figure 3: Preparation of Dried Brahmi leaves

BAJRA CLEANED, WASHED ,SOAKED IN WATER FOR 8 HOURS

↓

BAJRA PREPARED FOR SPROUTING AT ROOM TEMPERATURE

↓

BAJRA SUN DRIED FOR 3 DAYS

↓

SPROUTED BAJRA DRY ROASTED

↓

MILLING OF DRY ROASTED BAJRA

↓

SPROUTED, MILLED BAJRA STORED IN AIRTIGHT CONTAINER

Figure 4: Preparation of Sprouted, Milled Bajra

SORGHUM CLEANED, WASHED , SOAKED IN WATER FOR 8 HOURS

↓

SORGHUM PREPARED FOR SPROUTING AT ROOM TEMPERATURE

↓

SORGHUM SUN DRIED FOR 3 DAYS

↓

SPROUTED SORGHUM DRY ROASTED

↓

MILLING OF DRY ROASTED SORGHUM

↓

SPROUTED, MILLED SORGHUM STORED IN AIRTIGHT CONTAINER

Figure 5: Preparation of Sprouted, Milled Sorghum

GREEN GRAM

↓

CLEANING AND WASHING

↓

SOAK GREEN GRAM FOR 8 HOURS

↓

PREPARE GREEN GRAM FOR SPROUTING AT ROOM TEMPERATURE

↓

SPROUTED GREEN GRAM SUN DRIED FOR 3 DAYS

↓

SPROUTED GREEN GRAM DRY ROASTED

↓

MILLING OF DRY ROASTED SPROUTED GREEN GRAM

↓

STORED IN AIRTIGHT CONTAINER

Figure 6: Preparation of Sprouted, Milled Green gram

Table 2: Preparation of 3 Variations (V1, V2, V3) of Ready-to-cook Kadubu mix

Ingredients for Ready-to-Cook Kadubu mix	**Variation 1 (%)**	**Variation 2 (%)**	**Variation 3 (%)**
Sprouted, Milled Bajra	40	30	20
Sprouted, Milled Sorghum	20	30	40
Sprouted, Milled Green gram	20	20	20
Roasted Gingelly seeds, coarse powder	5	5	5
Roasted Groundnut coarse powder	7	6.5	6
Roasted Coriander coarse powder	0.5	0.5	0.5
Roasted Jeera coarse powder	0.5	0.5	0.5
Roasted Dry Red Chilli coarse powder	0.5	0.5	0.5
Roasted Pepper powder	0.5	0.5	0.5
Roasted Curry Leaves coarse powder	0.5	0.5	0.5
Brahmi Leaves (Dried Leaf powder)	0.5	1	1.5
Ghee	5	5	5

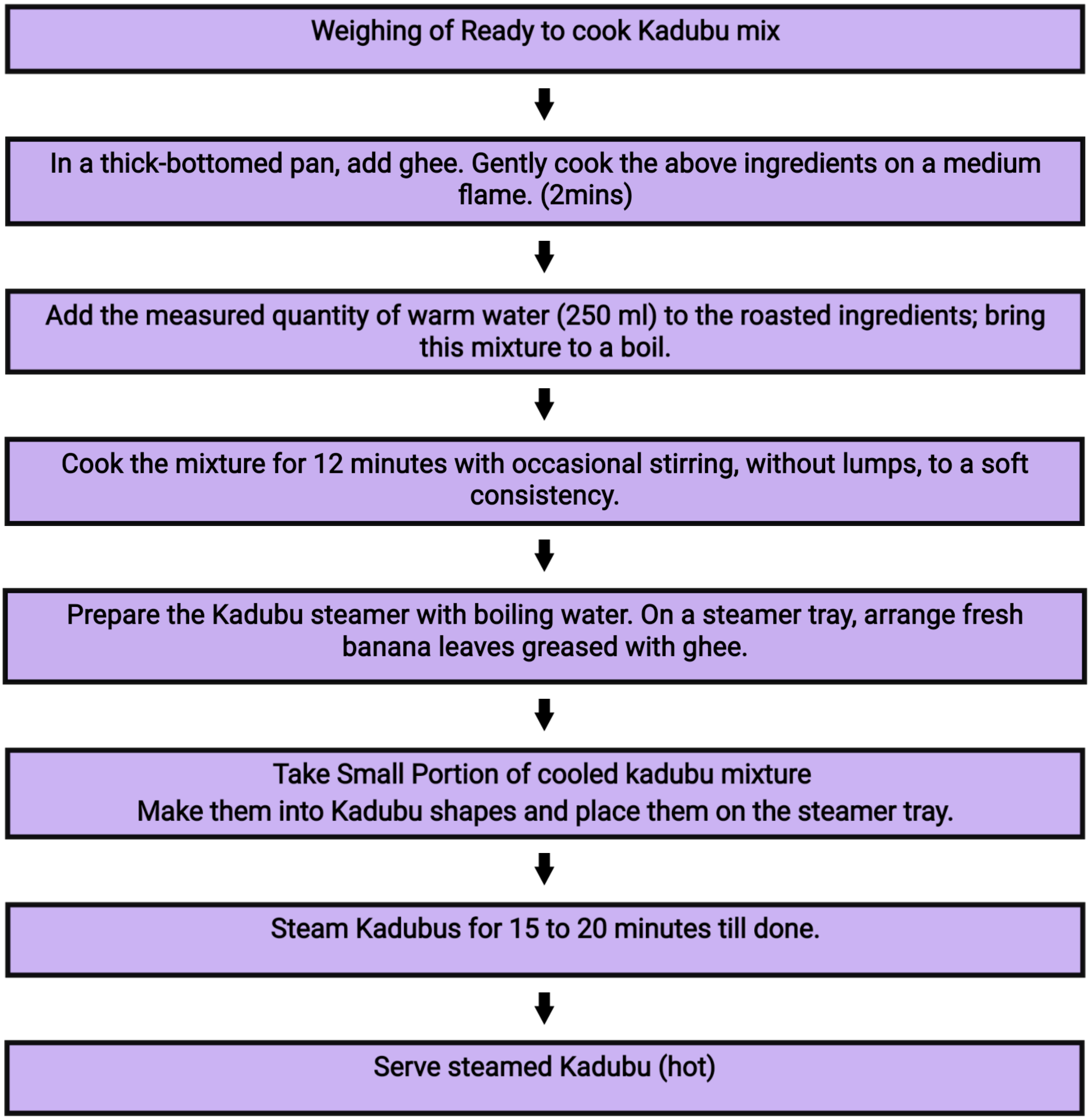


Figure 7: Preparation of Steamed Kadubu using Ready to Cook Kadubu Mix

Sensory Evaluation

Sensory evaluation using a 9-point Hedonic scale of Kadubu (Basic) and developed Kadubu (three variations) was carried out by 40 semi-trained panel members to study the acceptability of the developed Kadubu. Attributes such as appearance, color, taste, texture, and overall acceptability were rated from 1 to 9, where 1 indicates extreme dislike and 9 indicates extreme like. The scores were analyzed statistically by calculating the mean, ANOVA, and standard deviation to derive the results. The variation of Kadubu with the highest acceptability was selected for further investigation of nutrient composition, biochemical studies, and shelf life.

Nutrient Composition Analysis

The nutrients, including energy, carbohydrates, protein, fat, fiber present in each ingredient used to prepare the developed Kadubu Mix were calculated using the Indian Food Composition Table (IFCT-2017).

The best accepted developed Kadubu was subjected to micronutrient analysis (Calcium, Magnesium) at Chennai Mettex Lab PVT. Ltd. (NABL-Accredited, Drugs Control Department – Approved, FSSAI, ISO, Lab No. 25056514 Certified), Chennai.

Preliminary Phytochemical Screening

Phytochemicals are chemical compounds naturally present in plants that contribute to health effects. Commonly used Medicinal plants are rich bio-reservoirs of diverse phytochemicals. The medicinal properties of these plants are determined by their phytochemical constituents. The best-rated Kadubu was subjected to qualitative phytochemical screening to detect the secondary metabolites and primary metabolites. **(Kancherla, N., et al., 2019).**

Tests for Alkaloids

Mayer's Test: Add a few drops of Mayer's reagent to the extract. A creamy white precipitate indicates the presence of alkaloids.

Dragendorff's Test: Add Dragendorff's reagent to the extract. An orange or reddish-brown precipitate indicates alkaloids.

Tests for Flavonoids

Shinod's Test: Add magnesium turnings and a few drops of hydrochloric acid to the extract. A pink, red or magenta color indicates the presence of flavonoids.

Alkaline reagent test: Add few drops of sodium hydroxide to extract; a yellow coloration of the extract indicates the presence of flavonoids.

Tests for Tannins

Ferric Chloride Test: Add a few drops of ferric chloride solution to the extract. A greenish-black coloration indicates the presence of tannins.

Lead tetra acetic acid test: Add a drop of Lead tetra acetate solution to extract, formation of a white precipitate indicates the presence of tannins.

Tests for Saponins

Foam Test: Shake the extract with water. If foam persists for more than 10 minutes, saponins are present.

Tests for Steroids

Liebermann-Burchard Test: Add acetic acid to the extract followed by concentrated sulfuric acid. A green color change indicates the presence of steroids.

Tests for Phenols

Ferric Chloride Test: Add ferric chloride solution to the extract. A blue or green coloration indicates the presence of phenolic compounds.

Determination of Anti-Diabetic Activity

Inhibition of α-amylase Enzyme, α-amylase (0.5 mg/ml) was mixed with the sample at various concentrations (100-500 µg/ml) to which 1% of starch solution and 100 µl of 0.2 mm of phosphate buffer (pH-6.9) were added. The reaction was allowed to be carried out at 37°C for 5 min and terminated by addition of 2 ml of 3, 5-dinitrosalicylic acid reagent. The reaction mixture was heated for 15 min at 100°C and diluted with 10 ml of distilled water in an ice bath. α-amylase activity was determined by measuring color intensity at 540 nm in

Spectrophotometer. The Best rated Kadubu was evaluated for its anti-diabetic activity thus highlighting its efficacy in modulating glucose levels. **(Yadav, C. K., et al., 2024).**

Determination of Anti-Inflammatory Activity

Anti-inflammatory activity refers to the ability of a substance, food, or treatment to reduce inflammation or its associated symptoms. This activity can occur through various mechanisms, such as inhibiting the production of pro-inflammatory cytokines, blocking inflammatory pathways or scavenging reactive oxygen species, ultimately leading to a decrease in swelling, redness, and pain **(Ghosh et al., 2018).** The Best-accepted Kadubu was evaluated for its anti-inflammatory activity, to determine its potential as a natural therapeutic supplement and for presence of bioactive compounds that contribute to the reduction of inflammatory markers.

The anti-inflammatory activity of unknown crude extracts can be determined in vitro for inhibition of the denaturation of egg albumin (protein), • 0.2 ml of 1-2% egg albumin solution (from fresh hen's egg/or commercially available egg albumin powder), 2 ml of sample extract or standard (Diclofenac sodium) at varying concentrations, and 2.8 ml of phosphate buffer saline (pH 7.4) were mixed to form a reaction mixture of a total volume of 5 ml. • A total volume of 5 ml of the control was created by combining 2 ml of triple-distilled water, 0.2 ml of 1-2% egg albumin solution, and 2.8 ml of phosphate-buffered saline. • The reaction mixtures were then incubated at 37±2°C for 30 min and will be heated in a water bath at 70±2°C for 15 min. • After cooling, the absorbance was measured at 280 nm by a suitable UV/Vis spectrophotometer using triple distilled water as the blank. **(Pushpika, G. D. S., et al., 2023).**

The following equation was used to determine the % inhibition of protein denaturation. 100 Absorbance of control Absorbance of test sample:

Percentage of Inhibition = $\frac{(Ac - As)}{Ac} \times 100$

Ac = Absorbance of control

As = Absorbance of sample

Shelf life Study

The shelf-life study of the developed best rated **Ready to use Kadubu mix** was carried out at room temperature. The developed kadubu mix was stored under air tight condition using food grade high density polythene bags.

3. Results and Discussions

Table 3: Sprouting of Millets and Green gram

Green gram, Sorghum, and Bajra are subjected to a sprouting test to determine if the seeds are viable, healthy and capable of germinating.

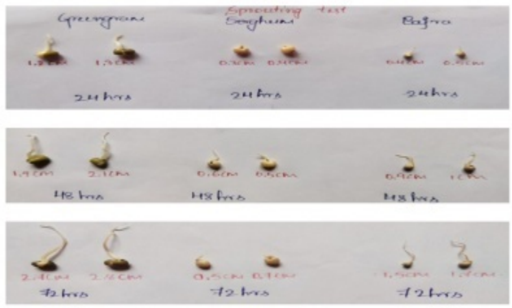
Seeds/Grains	Length of Sprouts in the given Time			Sprouting
	24 hrs	48 hrs	72 hrs	
Green gram	1.3 cm	2.1 cm	2.8 cm	
Sorghum	0.4 cm	0.6 cm	0.7 cm	
Bajra	0.5 cm	1 cm	1.7 cm	

Table 4: Ingredients used in preparing Regular Kadubu (Basic)

Ingredients	(%)
Broken White rice	60
Dry Coconut grated	28
Gingelly Seeds (White) coarsely powdered	5
Coriander powder	0.5
Jeera powder	0.5
Dry Red Chilli, coarsely powdered	0.5
Curry Leaves coarsely powdered	0.5
Ghee	5

Table 4, shows proportions of broken white rice, Dry coconut, Gingelly seeds, Coriander powder, Jeera powder, Red Chilli powder and Curry leaves powder for preparing Kadubu (Basic).

Table 5: Proportion of Ingredients used in the preparation of Ready to cook Kadubu Mix-Variations (V1, V2, and V3)

Ingredients for Ready-to-Cook Kadubu mix	Variation 1 (%)	Variation 2 (%)	Variation 3 (%)
Sprouted, Milled Bajra	40	30	20
Sprouted, Milled Sorghum	20	30	40
Sprouted, Milled Green gram	20	20	20
Roasted Gingelly seeds, coarse powder	5	5	5
Roasted Groundnut coarse powder	7	6.5	6
Roasted Coriander coarse powder	0.5	0.5	0.5
Roasted Jeera coarse powder	0.5	0.5	0.5
Roasted Dry Red Chilli coarse powder	0.5	0.5	0.5
Roasted Pepper powder	0.5	0.5	0.5
Roasted Curry Leaves coarse powder	0.5	0.5	0.5
Brahmi Leaves (Dried Leaf powder)	0.5	1	1.5
Ghee	5	5	5

Table 5, shows the proportion of Sprouted and Milled Bajra, Sorghum, Green gram, are the major ingredients followed by Roasted Gingelly Seeds, Roasted Groundnut Powder, Roasted Coriander Powder, Roasted Jeera Powder, Red Chilli Coarse Powder, Pepper Powder, Curry Leaves Powder , *Centella asiatica* leaves (Brahmi leaves) powder used in the preparation of Ready to cook Kadubu mix variations (V1, V2, V3).

Table 6: Sensory Scores of basic Kadubu and three variations of Kadubu (v1, v2, and v3) prepared from ready to cook kadubu mix (V1, V2, V3)
N=40

Sensory Characteristics	Steamed Kadubu	Mean	Standard Deviation	F-value	p-value
Appearance	Basic	8.03	0.77	5.053059	0.002284
	Variation 1 (v1)	7.62	0.66		
	Variation 2 (v2)	7.70	0.78		
	Variation 3 (v3)	8.16	0.69		
Colour	Basic	8.12	0.72	5.753888	0.000928
	Variation 1 (v1)	7.63	0.66		
	Variation 2 (v2)	7.63	0.69		
	Variation 3 (v3)	8.06	0.70		
Taste	Basic	7.95	1.10	5.213483	0.001858
	Variation 1 (v1)	7.48	0.92		
	Variation 2 (v2)	7.61	0.77		
	Variation 3 (v3)	8.18	0.67		
Texture	Basic	7.87	0.98	6.741699	0.000263
	Variation 1 (v1)	7.46	0.71		
	Variation 2 (v2)	7.67	0.72		
	Variation 3 (v3)	8.22	0.70		
Overall Acceptability	Basic	7.85	0.97	7.295248	0.000131
	Variation 1 (v1)	7.50	0.71		
	Variation 2 (v2)	7.70	0.71		
	Variation 3 (v3)	8.30	0.74		

The statistical analysis of 9 point hedonic rating , sensory scores of Basic kadubu and three variations of steamed Kadubu (v1, v2, v3) revealed that the steamed Kadubu variation 3 {Sprouted Milled Sorghum (40 g), Sprouted Milled Bajra (20 g), Sprouted Milled Green gram (20 g), Roasted Gingelly Seeds (5 g), Roasted Groundnut Powder (6 g), Roasted Coriander Powder (0.5 g), Roasted Red Chilli Powder (0.5 g), Roasted Pepper Powder (0.5 g), Roasted Curry Leaves Powder (0.5 g), Brahmi Leaves Powder (1.5 g), and Ghee (5 ml)} was best accepted and best rated with the mean scores of Appearance 8.16, Colour 8.06, Taste 8.18, Texture 8.22 and Overall acceptability 8.30.

In sensory evaluation, the F-value represents the ratio of variation between product samples to variation within samples. A higher F-value indicates greater differences among the tested samples. An F-value above 5 usually shows that there are clear differences between the samples tested. It is considered statistically significant if it is higher than the critical value at the 0.05 level.

The p-value determines whether these differences are statistically significant or due to random chance. If the p-value is less than 0.05, the differences are considered significant. These values are important as they ensure scientific accuracy and reliability in sensory research and product assessment.

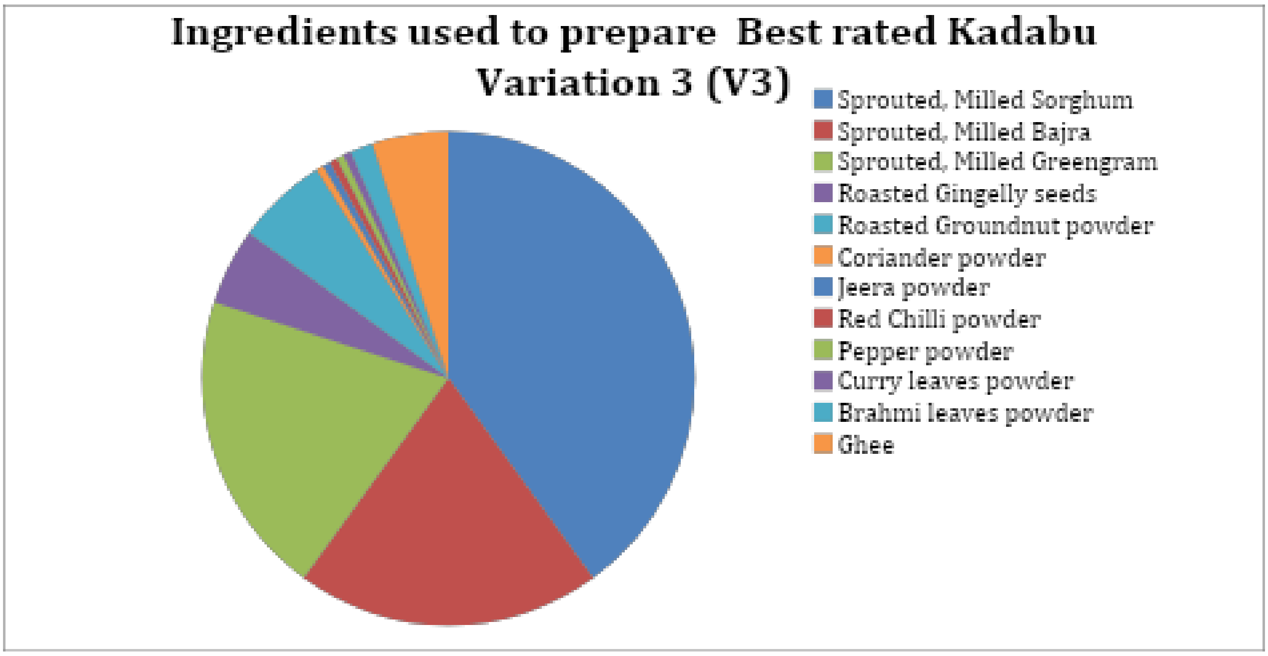


Figure 8: Proportion of Ingredients used in the preparation of best Rated Kadubu Mix (Variation 3)

In a thick bottom pan, Add ghee and gently warm Milled Millets, Milled Green gram, Powdered Brahmi leaves, nuts, oil seeds and spices mix

⬇

Add measured quantity of water (250 ml) to cook the mixture to boil

⬇

Cook mixture for 10 to 12 minutes and cool

⬇

Arrange Banana Leaves on tray and grease with Ghee

⬇

Take Small Portion of precooked mixture and shape into small balls or discs

⬇

Steaming Kadubu for 15 to 20 minutes till cooked

⬇

Kadubu is ready, Serve hot

Figure 9: Preparation of Best rated steamed Kadubu (variation 3)

Table 7: Nutritional Composition of Best rated, Ready to cook Kadubu mix (V3) per 100g

Nutrients	Amount/100g	% RDA#/Serve
Energy (Kcal) *	376*	13.18 %
Carbohydrates (g) *	52.1*	28.04 %
Protein (g) *	13.8*	17.96 %
Fat (g) *	11.8*	33.04 %
Fibre (g) *	11.8*	27.67 %
Calcium (mg) **	107.9**	7.55 %
Magnesium (mg) **	153.4**	24.40 %

Reference: Indian Food Composition (IFCT) NIN, ICMR-2017,
Serving Size – 70g
***IFCT Calculated**
****Proximate analysis in the laboratory.**
#Percentage RDA for serving of food is calculated based on 2000 kcal of energy and RDA of the nutrients as required for adults per day.

The nutritional composition of the best-rated kadubu mix (V3), determined through computational methods by using NIN IFCT book 2017, shows it is a highly nutritious food option, rich in essential nutrients. The nutritional content of the value-added ready-to-cook kadubu mix (V3), raw weight per 100 grams contains: Energy 376 kcal, Carbohydrates 52.1 g, Protein 13.8 g, Fat 11.8 g and Fibre 11.8 g (Indian Food Composition Table, ICMR-2017).

Proximate analysis of best-rated kadubu (V3): The best rated developed kadubu (V3) was subjected to micro nutrient analysis at Chennai Mettex Lab PVT. Ltd., (NABL-Accredited, Approved by FSSAI, APEDA, BIS, AGMARK, EIC, MOEF, Lab No. 25056514 Certified) Chennai. Proximate analysis showed the best rated Kadubu mix (V3) to contain Calcium 107.9 mg per 100 g of Kadubu mix and Magnesium 153.4 mg per 100 g of Kadubu mix.

Table 8: Phytochemical Screening of best rated, ready to cook Kadubu mix (V3) in different solvent system

Secondary Metabolites	Carbon tetra chloride	Ethyl acetate	Ethanol	Methanol
Alkaloids	+	-	+	+
Flavonoids	-	+	+	+
Steroids	-	-	+	+
Saponins	-	-	+	+
Tannins and phenolic compounds	-	-	+	+

Experimental results: - indicates absent; + indicates present; ++ indicates moderately present; +++ indicates highly present.

Table 8, shows the phytochemical screening of the ready-to-cook Kadubu mix using different solvents. It indicates that ethanol and methanol extracts contain all major secondary metabolites (alkaloids, flavonoids, steroids, saponins, tannins, and phenolics), while carbon tetrachloride and ethyl acetate extracts show limited presence of these compounds.

Table 9: Anti-Diabetic activity of best rated, ready to cook Kadubu Mix (V3) Absorbance of developed Product at 540 nm (Anti-diabetic Activity):

<table>
<tr><th>Sl no</th><th>Vol of Substrate (ml)</th><th>Vol of Enzyme (ml)</th><th></th><th>Vol of Strach (ml)</th><th></th><th>Vol of DNS (ml)</th><th></th><th>Vol of Water (ml)</th><th>OD at 540 nm</th></tr>
<tr><td>1.</td><td rowspan="5">1 ml</td><td rowspan="5">1 ml</td><td rowspan="5">Incubate for 10 mins at room temperature</td><td rowspan="5">0.5 ml</td><td rowspan="5">Incubate for 10 mins at room temperature</td><td rowspan="5">1 ml</td><td rowspan="5">Incubate in water bath for 5 mins</td><td rowspan="5">6.5 ml</td><td>0.63 (0)</td></tr>
<tr><td>2.</td><td>0.03</td></tr>
<tr><td>3.</td><td>0.21</td></tr>
<tr><td>4.</td><td>0.28</td></tr>
<tr><td>5.</td><td>0.42</td></tr>
</table>

The best-rated Kadubu mix (V3) was evaluated for its anti-diabetic activity highlighting its efficacy in modulating glucose levels. Absorbance measurements at 540 nm such as 0.63 (0), 0.03, 0.21, 0.28 and 0.42 indicate the presence of bioactive compounds that contribute to its potential anti-diabetic effects.

Table 10: Percentage of Inhibition in V3, best rated ready to cook Kadubu Mix (Anti-diabetic Activity):

Compound	Concentration	Mean Absorbance at 540 nm (0.05)	% of Inhibition
1	100	0.03	95.23
2	100	0.21	66.66
3	100	0.28	55.55
4	100	0.42	33.33

The percentage of inhibition of anti-diabetic activity in the developed product demonstrates significant potential for modulating glucose levels. The results such as 95.23%, 66.66%, 55.55% and 33.33% indicates that this product contains bioactive compounds that contribute to its efficacy, highlighting its potential as a functional food with Anti-diabetic activity.

Calculation Formula:

$$\textbf{\% of Inhibition} = \frac{(Ac - As)}{Ac} \times 100$$

Ac = Absorbance of control
As = Absorbance of sample

Table 11: Anti-Inflammatory Activity of best rated, ready to cook Kadubu mix (V3) Absorbance of Developed Product at 660 nm (Anti-inflammatory Activity):

Sl no	Volume of BSA (ml)	Volume of Phosphate buffer (ml)	Volume of Plant Extract (µl)		OD at 660 nm
1.	5 ml	2.5 ml	50 µl	**Incubate in boiling water bath for 5 mins**	0.08 (0)
2.					0.02
3.					0.03
4.					0.05
5.					0.06

The best-accepted ready to cook Kadubu mix was subjected to determination of anti-inflammatory activity, highlighting its potential as a natural therapeutic agent. Absorbance measurements at 660nm such as 0.08 (0), 0.02, 0.03, 0.05, and 0.06 indicate the presence of bioactive compounds that contribute to the reduction of inflammatory markers.

Table 12: Percentage of Inhibition of best rated, ready to cook Kadubu mix V3 (Anti-Inflammatory Activity)

Compound	Concentration	Mean Absorbance at 660 nm	% of Inhibition
1	00	0.02	99.75
2	100	0.03	62.5
3	200	0.05	37.5
4	500	0.06	2.5

The percentage of inhibition of anti-inflammatory activity in the developed product demonstrates significant potential for reducing inflammatory conditions. The results such as 99.75 %, 62.5%, 37.5% and 2.5% indicate that this product contains bioactive compounds contributing to its efficacy, highlighting its potential as a functional food that promotes health and can help to prevent inflammation-related diseases.

Calculation Formula:
% of Inhibition = (Vt / Vc - 1) × 100
Vt = Absorbance of test sample
Vc = Absorbance of control

Table 13: Shelf Life Study of ready to cook Kadubu mix (V3) package, stored at room temperature

Sl no	Attributes	Duration		
		15 days	**30 days**	**45 days**
1.	**Appearance**	Good Acceptable	Good Acceptable	Good Acceptable
2.	**Colour**	Creamish green Acceptable	Creamish green Acceptable	Creamish green Acceptable
3.	**Taste**	Good, Acceptable	Good, Acceptable	Good, Acceptable
4.	**Odour**	No off odour Accepable	No off odour Acceptable	No off odour Acceptable
5.	**Texture**	Good Acceptable	Good Acceptable	Good Acceptable
6.	**Overall Acceptability**	Good, Acceptable	Good, Acceptable	Good, Acceptable

Table 13, shows the shelf-life study results of the best-rated ready-to-cook Kadubu mixture (V3), stored in food-grade, and airtight packaging material. Samples stored at room temperature were checked regularly and stored airtight after every checking.

The best-rated ready-to-cook Kadubu mixture (V3) remained in good condition, with the absence of off-flavors, undesirable color changes, and undesirable texture changes until 45 days in airtight packaging, stored at room temperature.

Table 14: Regular white Rice based Kadubu (Basic) and Best accepted Millet based Kadubu (V3)

Sl. No		**Regular white rice Kadubu (Basic)**	**Best accepted Millets Kabudu (Variation V3)**
01.	**Ingredients**	Broken White Rice (60 g), Dry Coconut (28 g), Roasted Gingelly Seeds (5 g), Coriander Powder (0.5 g), Jeera Powder (0.5 g), Red Chilli Powder (0.5 g), Curry Leaves Powder (0.5 g) and Ghee (5 ml).	Sprouted Milled Sorghum (40 g), Sprouted Milled Bajra (20 g), Sprouted Milled Greengram (20 g), Roasted Gingelly Seeds (5 g), Roasted Groundnut Powder (6 g), Coriander Powder (0.5 g), Jeera Powder (0.5 g), Red Chilli Powder (0.5 g), Pepper Powder (0.5 g), Curry Leaves Powder (0.5 g), Brahmi Leaves Powder (1.5 g) and Ghee (5 ml).

02.	**Method of Cooking**	Steaming	Steaming
03.	**Health Benefits**	Does not contain Millets, Green gram and Brahmi leaves.	Contain Millets, Green gram and Brahmi leaves. According to **Sarita, Ekta Singh, 2016** , Millets have shown to help in reducing the risk of Diabetes, Cardiovascular disorders, Cancer, Celiac Disease with Anti-inflammatory and Anti-microbial potential. According to **Kulsoom Zahara et al., 2014** Brahmi leaves help to improve Cognitive function and possess Anti-diabetic, Anti-ulcer, Anti-mutagenic, Anti-inflammatory, Immune-modulation, Slimming effect, Cardio, Skin and Radio protective activity
04.	**Nutrients Composition/100 g edible portion of raw ingredients (Calculated using IFCT, NIN 2017)**		
	Energy (Kcal)	464	376
	Carbohydrates (g)	50.1	52.1
	Protein (g)	8.2	13.8
	Fat (g)	25.4	11.8
	Fibre (g)	7.6	11.8
	Calcium (mg)	89.4	107.9
	Magnesium (mg)	63.4	153.4

Table 14, shows the ingredient composition and the nutritive value of regular Kadubu (Basic) and best-rated value-added Kadubu (v3) prepared from ready-to-cook Kadubu mix (V3). The developed product shows enhanced levels of protein, fiber, calcium, and magnesium compared to regular Kadubu (Basic). According to **Sarita and Ekta Singh (2016),** millets help to reduce the risk of diabetes, cardiovascular disorders, cancer and celiac disease and possess anti-inflammatory and antimicrobial potential.

According to Kulsoom **Zahara et al. (2014),** Brahmi leaves help to improve cognitive function and possesses anti-diabetic, anti-ulcer, anti-mutagenic, anti-inflammatory, immune-modulator, slimming effect, cardio and skin-protective activity.

Conclusion

The Ready-to-Cook Kadubu Mix, developed in this study is convenient to use and is prepared with natural, good-quality, locally available ingredients. The results of this investigation indicate that value addition to kadubu using locally available ingredients enhances micronutrients Calcium and Magnesium. Regular rice Kadubu (Basic) and Steamed kadubus (v1, v2, and v3) were prepared using the developed and standardized Ready-to-Cook Kadubu Mix (V1, V2, and V3). Results of the sensory evaluation, using a 9-point hedonic rating scale, between Rice Kadubu (Basic) and Millets Kadubu (3 variations) showed that all three variations of the value-added kadubu were acceptable. Kadubu Variation v3 (containing millets, green gram, and Brahmi leaves powder) was the most accepted by the semi-trained sensory panelists, with mean scores of 8.16 for appearance, 8.06 for color, 8.18 for taste, 8.22 for texture and 8.30 for Overall acceptability. The results of this study show that incorporating the functional ingredient Centella Asiatica (Brahmi) leaf powder at 1.5% resulted in a value-added kadubu with acceptable color, taste, flavor, texture, and overall acceptability.

The best rated (V3) steamed Kadubu prepared using millets, green gram, Centella Asiatica (Brahmi) leaf powder contains antioxidants and phytochemicals such as flavonoids, phenols, and triterpenoids. Spectrophotometric analysis showed potential anti-diabetic and anti-inflammatory properties. There is increasing evidence highlighting that inflammation and nutrition are strongly linked. Nutrition influences the body's inflammatory response, and inflammation influences nutrition at different levels. Plant based foods with promising therapeutic potential and fewer adverse effects are gaining attention for Diabetes control. Anti-diabetic medicines, though effective, may have undesirable effects and can vary from individual to individual. The various mechanisms by which medicinal plants demonstrate antidiabetic activity include glycosidase (glycosidase) inhibition, α-amylase inhibition, and inhibition of hepatic glucose-metabolizing enzymes. Furthermore, selected plant based foods can be effective in stimulating insulin production or acting as an insulin mimic, stimulating glycogenesis, reducing the release of glucagon and other hormones that counteract insulin action, exhibiting antioxidant mechanisms, preventing glycosylation of hemoglobin, and regulating glucose absorption from the gut. The plant based, natural, ingredients used in the preparation of the value-added kadubu can also be employed to develop a wide range of diversified value added food products. A market survey carried out showed that ready-to-cook kadubu mix using Millets, Green gram and Brahmi leaves is not available in the market. The cost of 100g of the best-rated kadubu mix (V3) is Rs. 50.66/-is rounded to Rs. 50/-.

The best rated (v3) steamed Kadubu prepared using millets, green gram, Centella Asiatica (Brahmi) leaf powder, prepared using Ready-to-cook Kadubu mix (V3) developed and standardized in this study is a novel approach that can be prepared at both the domestic and commercial levels. The best rated value added Kadubu (v3), prepared from 'Ready to cook millet based Kadubu mix' (V3), developed in this study, has good nutritional value, compared to the Regular kadubu (Basic) prepared using white rice. It can be consumed by health conscious people across all age groups.

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