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Development of instant pancake mix with finger millet flour and shelf-life studies

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Abstract
This study aimed to develop a pancake mix having finger miller flour as main ingredient. The finger millet varieties grown in Andhra Pradesh such as Vegavathi (VR929), Indravati (VR1101) and Suvarna Mukhi (VR988) in Various compositions were used for preparation of Pancakes. Pan cakes were prepared by different ratios ranging from 90: 10 to 60:40. Sensory evaluation studies were conducted to assess the pancakes' quality. The finalized instant pancake mix was subjected to shelf life studies and moisture analysis to determine the storage abilities. After optimization of composition of finger millet flour and type of finger millet flour, the combination of finger millet flour (70%) of Vegavathi variety along with wheat flour (30%) was proven to be best proportion for preparation of instant pan cake mix. The sensory evaluation studies were demonstrated that the Vegavathi variety of finger millet flour excelled in all sensory characteristics, scoring 8.33 in overall acceptability. It had substantial amount of minerals like calcium (Ca), iron (Fe), magnesium (Mg), and potassium (K). The shelf life studies with instant pan cake mix of Vegavathi variety also showed less MPN (Most Probable Number) results compared to other varieties.

Keywords: Pancakes, instant mix, finger millers, Vegavathi-(VR929), indravathi- (VR1101) and Suvarna Mukhi-(VR988)

Introduction
Finger millet is a member of the millets group, which holds significance as crops in the semiarid tropics of Asia and Africa, particularly in countries like India, Mali, and Nigeria. Approximately 97% of millet production occurs in developing countries. The consumption of millets by humans dates back around 7,000 years. Millet crops like ragi, korra, sama and gantelu were claimed to have been found in an Indian archaeological site dated to 1800 BCE (Late Bronze Age) (Achaya, 2003) [2].

Millet crops are preferred for their productivity and ability to thrive in short growing seasons, especially in dry, high-temperature conditions. Millets have their origins in various regions across the globe. Primarily, the finger millet will be processed in to millet flour as whole flour is the main product and its processing is difficult due to its smaller seed size and the bran is tightly bound to the endosperm. The other processing of form of the finger millet is malting. This malting is a process of germinating the grain to activate the enzymes and used for production of brewed beverages such as beer. Finger millets have good malting activity where starch turns in to carbohydrate and simple sugars. Malted finger milled can be used as food for infants a it is easily digestible (Borlaug *et al*., 1996) [4]. The straw from finger millet serves as animal fodder. In India, finger millet can be milled into flour and utilized to puddings, porridge and prepare cakes. The finger millet flour is commonly consumed with boiled water, yogurt, milk and is used to make flatbreads such as thicker, unleavened roti and thin leavened dosa. In South India, finger millet features in diverse recipes, including idli, laddu and dosa. It possess high iron and calcium content hence paediatrician's recommend finger millets to use in preparing baby food.

Pancake is a flat cake which is thin and round and made from starch-based batter containing milk, eggs, butter and cooked on griddle or frying pan with butter or oil. The present study is aimed to develop a pancake mix having finger miller flour as main ingredient. Pancakes with finger millet flour will have additional nutrients and health benefits than the regular recipes. In this study, three finger millet varieties were utilized they are Vegavathi, Indravati, and Suvarna Mukhi.

Materials and Methods

Procurement of finger millets

The millet varieties namely Vegavathi (VR929), Indravati (VR1101) and Suvarna Mukhi (VR988) were procured from ARS (Agricultural research stations), Vijaya Nagaram, ANGRAU. The collected millets were cleaned to remove dust and other extraneous materials and preserved at room temperature in plastic containers for preparing finger millet flour.

Assessment of quality and properties of Finger millet: Physical properties

The sizes of finger millets was evaluated by measuring the length, thickness and diameter of the vernier callipers having a resolution of 0.05 mm (Roopa *et al*., 2013) [9]. Lightness value and colour of the grains were determined by using colorimeter (Sareepaung *et al*., (2008) [10]. The seed weight was evaluated (William *et al*., 1983) [16]. 1 kg approximate weight was roughly divided into 10 equal portions and then 1000 number of grains were collected from each portion and weighed on a digital electronic balance. The finger millet sample was filled into 50 ml cylinder up to 50 ml mark and weighted. Bulk density was defined as the sample's mass per unit volume (g/ml). The assessment of the grain-to-flour ratio followed the methodology outlined by (Shashi, 2005) [11]. Approximately 100 grams of grains from all varieties (Vegavathi, Indravathi, Suvarnamukhi) were measured and ground into flour using a miller. The recovered flour weight was then determined. Subsequently, the grain-to-flour ratio was evaluated and expressed as a percentage.

Functional Properties

Germination percentage was evaluated using the procedure outlined in the following method described by (Aykroyd and Doughty, 1981) [1]. 100 seeds underwent a water wash for 6 times and soaked in distilled water. After draining excess water, the seeds were bundled in muslin cloth and subjected to a 5 kg weight. Germination of these seeds took place at a temperature of 27± °C for 24 hours.

Hydration capacity

Hydration capacity of finger millets was measured by using the procedure described by (William *et al*., 1983) [16]. Approximately 1000 seeds were measured, placed in a flask, and soaked in water. Subsequently, the water drained off, and the seeds were left to air dry before being weighed. Hydration Index and Hydration capacity were measured with below mentioned formula.

Hydration capacity = after soaking weight – before soaking weight

$$\text{Hydration Index} = \frac{\text{Hydration capacity}}{\text{Seeds weight}}$$

Swelling capacity of grains

Swelling capacity of grain was assessed by modified method (Ooraikul and Moledina 1981) [7]. About 0.5 g of sample was transferred into a 15 ml graduated centrifuge tube and mixed with 15 mL distilled water. The tubes were placed in a heating block at 900C for 1 hour with periodic shaking. The grains were placed in centrifuge tubes and spun at 3000 rpm for 15 minutes. Excess water was decanted after cooling. The weight of grains was determined after absorbing excess water on a blotting paper. Swelling index was calculated by formula described by (William *et al*., 1983) [16].

$$\text{Swelling index} = \frac{\text{Swelling capacity}}{\text{Seed weight}}$$

Water absorption capacity

The tendency of water absorption of finger millets was assessed by described method (Bello, 2004) as modified by (Subramanian *et al*., 1986) [15]. Precisely 0.5 grams of finger millet sample were measured into a test tube containing 15 ml of distilled water. This mixture was subjected to heat through a heating block at 90 °C for one hour. After cooling, the suspension was being centrifuged at 7000 rpm for 15 minutes, and the resulting residue was preserved. The residue underwent two washes with a small quantity of water, and the combined residue was adjusted to a volume of 50 ml. A 10 ml aliquot was then evaporated to dryness at 110 °C, and material weight was recorded. The findings were expressed as milligrams per 100 grams of flour.

Swelling capacity of flour

Swelling capacity of flour was described by (Subramanian *et al*., 1986) [15]. About 0.5 g of flour was added into a graduated centrifuge tube. Then Distilled water were added to reach the 5 ml mark, and the water volume was recorded. The flour and water mixture were accurately transferred to a 50 ml tube by introducing an additional 10 ml of distilled water. The tube was then subjected to a heating block for one hour at 90 °C with periodic shaking. Following cooling, the suspension was transferred to a centrifuge tube and spun at 5000 rpm for 10 minutes. Excess water adhering to the sediment was eliminated, and the volume of the wet sediment was measured as Vt. weight of wet sediment (Wt) was also determined. The results were demonstrated as a ratio of the final volume or weight (Wt) to the initial volume (Vi) or weight, reported as the swelling capacity of the flour.

Nutritive Analysis of Finger Millet Varieties

Nutritive values of finger millets were analysed in terms of protein, iron, calcium and zinc using AOAC, 2006 protocol.

Preparation of pan cake

Finger millets were pre-treated before grinding. Standardization of three different pan cake mixes was done with three finger millet varieties selected for the study. Different proportions of millet flour of three varieties a primary ingredient, whole wheat flour as a second main ingredient, and various other ingredients were also used for preparation of instant pan cake mix. Pan cakes were prepared by mixing different proportions starting from 90: 10 to 60: 40 of finger millet flour and wheat flour.

Sensory evaluation

Sensory evaluation studies were performed in so that we can determine the quality of the pancakes. The developed pan cake sample of instant pancake mix was evaluated by trained panel of judges using 9-point hedonic scaling for sensory properties like colour, appearance, consistency, flavour, taste and acceptability. The finalized instant pancake mix was

studied for shelf-life properties and moisture analysis to determine the storage abilities.

Shelf-life studies

Finger millet pan cake mix with different storage conditions (ambient and – 40 °C) were subjected to moisture and microbial analysis for determination of shelf life of the instant pancake mix. Moisture of the instant pancake mix was determined using oven dry method by placing the dish containing sample in electric oven maintained at 130 °C to 133 °C for two hours. Total viable count of the finger millet pan cake mix was assessed by colony count method. The samples stored in different storage conditions were subjected for incubation in nutrient agar medium and observed for growth of bacterial colonies. About 10 mg of sample dissolves in 10 ml of water to obtain 1000 µg/ml of sample concentration. The sample at 1000 µg/ml was sampled into nutrient agar plate and incubated at 35 °C for 24 hours. After incubation period, colonies upon the plate were counted by using colony counting equipment.

Results and Discussion

Finger millet samples

These are the three finger millet varieties used in the present studies are shown in the figure 1.

Fig 1: Finger Millet images of selected variety (A) Vegavathi, (B) Indravati, and (C) Suvarna Mukhi

Physical properties

In order to study the physical properties of the finger millets varities, size, bulk density and volume were determined. The results of physical properties (size, weight, volume) of germinated and raw finger millets are presented in Table 1. The mean values of size of raw Finger millets range from 0.50 mm to 1.29 mm. The mean values of 1000 seed weight ranged from 2.89 mm to 3.17 mm. Generally, majority of finger millets is available in brown colour and some cultivars are also available in creamy white and black colour. In the present study finger millets are in brown colour. The average 1000 seeds weight of raw Finger millets were in the range of 3.05 g to 3.25 g whereas the germinated millets ranged from 3.10 g to 4.26 g. The average volume of 1000 millets was noticed with in the ranged of 3.08 mL to 3.29 mL for raw and 3.56 mL to 4.59 mL. Bulk density of germinated and raw samples was in range of 0.71 to 0.84 and 0.61 to 0.78 g/ml.

Table 1: Physical properties of finger millets

Parameters	Suvarnamukhi		Vegavathi		Indravathi	
	Raw	Germinated	Raw	Germinated	Raw	Germinated
Millet size (mm)	0.5	0.89	1.29	1.88	0.59	1.08
Bulk density (g/ml)	0.54	0.48	0.75	0.62	0.71	0.61
1000 seed weight (g)	3.23	4.26	3.25	4.22	3.05	3.10
1000 seed volume (ml)	3.29	4.14	3.31	4.59	3.08	3.56

Functional properties

Hydration capacity of 0.65 to 0.85 g/100 g and 1.24 to 1.83 g/100 g respectively was achieved for germinated and raw grains. The average Hydration Index value was achieved to be in 0.18 to 0.24 and 0.38 to 0.55 ranged respectively for raw and germinated grains. Hydration capacity results were tabulated in table 2. Swelling capacity was observed in range of 2.11 to 2.36 for raw and 2.59 to 2.84 for germinated grains. Swelling index of raw and germinated grains ranged between 0.65 to 0.72 and 0.71 to 0.89% respectively. The swelling capacity, swelling index and bulk density are tabulated in table 2.

Table 2: Functional properties of finger millets

Parameters	Suvarnamukhi		Vegavathi		Indravathi	
	Raw	Germinated	Raw	Germinated	Raw	Germinated
Hydration capacity (g/ml)	0.54	1.07	0.73	1.13	0.65	1.05
Hydration Index (%)	0.24	0.55	0.22	0.50	0.15	0.34
Swelling capacity (g/ml)	2.0	2.52	2.16	2.74	2.26	2.63
Swelling Index (%)	0.65	0.75	0.67	0.86	0.69	0.77

Grain-flour percentage of raw Finger millet varieties were in 97.6% for Suvarnamukhi, 96.9% for Vegavathi and 98.5% for Indravathi. Germination percentage was high in Indravathi variety with 99.2% germination rate, followed by Suvarnamukhi and Vegavathi with 99% and 98.5% germination rate respectively. A study conducted by Sowbhagya Lakshmi, 2011 reported that the germination percentage of different millet varieties ranged between 98 to 99%. Similar trend was observed in the present investigation. Germination study results along with grain to flour percentage data were represented in table 3.

Table 3: Germination Study

Parameters	Suvarnamukhi	Vegavathi	Indravathi
Germination (%)	98.5	99.0	99.2
Grain to flour%	97.6	96.9	98.5

Water absorption capacity in range of 1.63 to 1.87 ml/g was noticed for raw samples whereas 1.54 and 1.76 range noticed for malted samples. The findings proved that, the tendency of water adsorption, of Indravathi raw variety exhibit high and Suvarnamukhi malted variety exhibit water absorption efficiency. Among millet samples studied, raw samples show high water adsorption capacity than malted millets (Table 5). In the same way, swelling capacity of raw millet samples exhibit high than malted samples (Table 5). The study results were supported by findings reported by Nazni and Bhuvaneswari, 2015 [6] and Ramashia *et al*., 2018 [8]. The results of mean values obtained in Water absorption capacity study of millet samples were presented in table 4.

Table 4: Results of Water absorption capacity and Swelling capacity of raw and malted finger millet seeds

Varieties	Water absorption capacity (ml/g)		Swelling capacity (g/100g)	
	Raw	Malted	Raw	Malted
Suvarnamukhi	1.81	1.54	8.5	6.1
Vegavathi	1.63	1.56	9.1	8.0
Indravathi	1.87	1.76	9.4	8.1

Preparation of instant pancake mix

Finger mill*et al*ong with wheat flour at various compositions were used as key ingredients for preparing instant pancake mix. A total number of 12 trials were examined to get the best combination of ingredients for the product. All three varieties of finger millets 12 combinations were mixed in different proportions and compared for the effectiveness of the pan cake quality. Preparation of Instant Pan cake with Finger millet flour of variety were shoed in Figure 2.

Fig 2: Preparation of Instant Pan cake with Finger millet flour

Sensory evaluation studies

Sensory evaluation studies carried out on the pancakes prepared using the finger millet based instant pancake mixes developed in the present study. The average score of the instant pan cakes mix at 90:10 ratio was found 7.2 for Suvarnamukhi (code: S1), 7.3 for Vegavathi (code: V1) and 7.1 for Indravathi (code: I1). The average score of the instant pan cakes mix at 80:20 ratio was found 6.9 for Suvarnamukhi (code: S2), 6.1 for Vegavathi (code: V2) and 6.8 for Indravathi (code: I2). The average score of the instant pan cakes mix at 70:30 ratio was found 8.7 for Suvarnamukhi (code: S3), 9.0 for Vegavathi (code: V3) and 8.5 for Indravathi (code: I3). The average score of the instant pan cakes mix at 60:40 ratio was found 6.3 for Suvarnamukhi (code: S4), 6.5 for Vegavathi (code: V4) and 6.0 for Indravathi (code: I4). The results proved that the pan cakes prepared with instant pan cake mix of Vegavathi finger millet variety (code: V 3) found best for preparation. The results of sensory evaluation parameters are displayed in Table 5.

Table 5: Scores of Sensory evaluation of Instant pan cake mix in different ratios

Trails	Suvarnamukhi		Vegavathi		Indravathi	
	Code	Result	Code	Result	Code	Result
90:10	S 1	7.2	V 1	7.3	I 1	7.1
80:20	S 2	6.9	V 2	6.1	I 2	6.8
70:30	S 3	8.7	V 3	9.0	I 3	8.5
60:40	S 4	6.3	V 4	6.5	I 4	6.0

Analysis of Nutritive values

The moisture content analysis were performed by different time period durations like Immediate preparation of flour, After 15 days, one month, one and half month, two months, two and half months and three months. Analysis were performed for two different conditions like room temperature and freezing conditions. The moisture content in the prepared instant pan cake mix was found to be 9 -11% range in 1 to 15 days under storage. The result of moisture analysis are shown in table 6.

Table 6: Result of moisture analysis of instant pan cake mix

S No	Sample name			Moisture content (days)				
		1	15	30	45	60	75	90
1	Suvarnamukhi	10.32	10.21	9.16	8.74	8.06	7.01	6.14
2	Vegavathi	11.14	10.98	10.01	9.96	8.69	7.92	6.09
3	Indravathi	10.20	10.12	9.56	8.52	8.01	7.16	6.54
4	Suvarnamukhi- 40 °C	10.06	10.04	9.87	8.61	8.19	7.08	7.25
5	Vegavathi-40 °C	10.91	10.62	10.09	9.37	8.86	7.99	8.37
6	Indravathi-40 °C	10.38	10.14	9.64	8.15	8.07	7.19	7.79
Average		10.50	10.35	9.72	8.89	8.31	7.39	7.03
Mean		10.35	10.18	9.76	8.68	8.13	7.18	6.90
Standard deviation		0.43	0.37	0.34	0.66	0.37	0.44	0.93

Nutritive values of the raw and germinated finger millets of selected varieties are tested, compared and shown in table 7. The Protein present in raw and malted millet varieties was in range of 8.3 to 8.6 and 8.1 to 9.2 g/100 g respectively. Statistical analysis proved that there ware significant difference in protein content among the varieties studied. The mean values were presented in the Table 7. Protein content of Finger millet as reported in the Indian Food Composition Table is 7.16 g /100 g (Longvah *et al*., 2017) [5], which are on par with the findings of present investigation. These results were also in agreement with previous studies conducted by Shelly *et al*., 2016 [13] and Shayo *et al*., 2001 [12], reported the protein content of raw and malted Finger millet flour in 8.91 g and 12.50 g respectively, which are in line with the present study.

Table 7: Nutritive values of raw and germinated seeds of the selected finger millets

Varieties	Protein (g)		Calcium (mg)		Iron (mg/100 g)		Zinc (mg/100 g)	
	Raw	Germinated	Raw	Germinated	Raw	Germinated	Raw	Germinated
Suvarnamukhi	8.3	8.7	376.5	409	2.7	1.6	3.24	2.01
Vegavathi	7.5	8.1	381.4	419	3.4	2.2	3.81	2.19
Indravathi	8.6	9.2	395.8	435	3.9	2.8	3.96	3.11

Calcium content of raw and malted Finger millets was 376.5 to 395.8 mg/ 100 and 409 to 435 mg/ 100 g respectively. Calcium content increased during the process of malting. The increase in calcium due to reduction of phytates and oxalic acid, which binds calcium to form insoluble calcium oxalates. Calcium content of Finger millet as reported in the Food Composition Table is 364 mg/100 g (Longvah *et al*., 2017) [5]. Previous studies reported that Calcium content of 36 genitically varied varieties (Longvah *et al*., 2017) [5] Finger millet ranged between 162 to 487 mg/ 100g which are in tune with the present investigation. Iron content of raw and malted Finger millet varieties in 2.7 to 3.9 mg/ 100 and 1.76 to 2.8 mg/ 100 mg range respectively. Iron content of Finger millet is 4.6 mg/100 g by Indian Food Composition Tables by ICMR (Longvah *et al*., 2017) [5]. Zinc content of raw and malted varieties in 3.24 to3.96 and 2.01 to 3.11 mg/ 100 g range respectively. Zinc content of Finger millet is 2.53 mg/100 g by Indian Food Composition Tables by ICMR, but the present study proved higher values of Zinc content in all four Finger millet varieties. Among all studied varieties, Indravathi variety was found rich all protein, calcium, zinc and Iron is compared to other varieties.

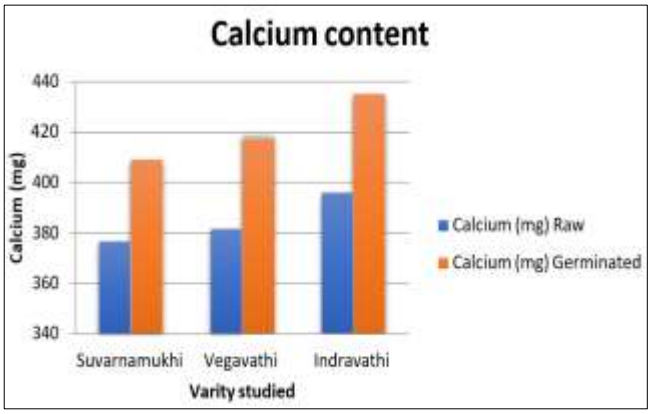

Fig 3: Comparison of calcium content of the finger millets varieties

Microbial analysis for shelf-life study

The microbial analysis of the finger millet flour prepared with all selected varieties proved that instant pan cake mix prepared with Vegavathi finger millet variety was shown less MPN number compared to other varieties. The results of shelf-life studies are presented in table 8. The microbial colonies grown in agar plates are presented in figure 4.

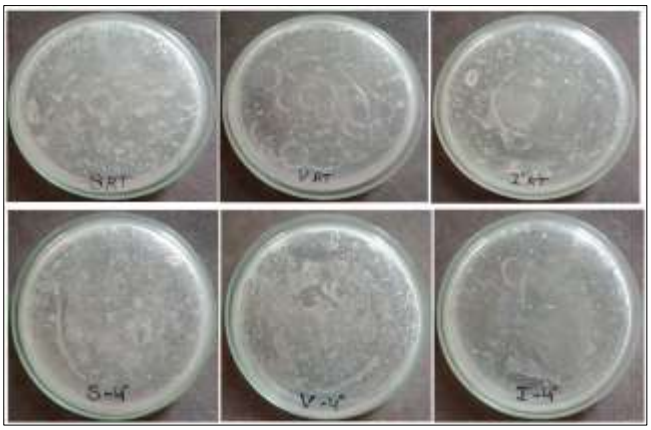

Fig 4: Total microbial count for instant pan cake mix Table 8: The results of shelf-life studies

Table 8: The results of shelf-life studies

S. No	Sample Name	Total colony count result (MPN)
1.	Suvarnamukhi	1776
2.	Vegavathi	1040
3.	Indravathi	3200
4.	Suvarnamukhi-40 °C	1920
5.	Vegavathi-40 °C	1830
6.	Indravathi-40 °C	1904

Related to other cereal grains, finger millets are primarily composed of starch. The protein content is relatively similar and comparable to rice, wheat and maize. Finger millets possess superior protein quality, which is generally as good as or better than other cereals. It also has the lowest fat content among these grains. Notably, millets exhibit distinctive high ash (mineral) content and significantly high iron and phosphorus content. It stands out with the highest calcium content (344mg/100 g) among all food grains. Millet grains are characterized by their high fibre and lower digestibility of nutrients. Therefore, this study successfully prepares instant mix by substituting gluten containing wheat flour with gluten-free finger millet flour. The utility of finger millet flour adds additional nutritive value to pan cake preparation.

Conclusion

The present study was undertaken to develop and evaluate the instant finger millet mix for preparation of pan cakes. The study concluded that the composition 70% of finger millet flour and 30% of wheat flour was found best recipe for

preparation of instant mix contains meeting all the physical properties of pan cake quality. All the instant pan cake mix are stable in terms of moisture up to 90 days of stored at room temperature and -40 °C. sensory evaluation study proves the composition 70% of finger millet flour and 30% of wheat flour was best for preparation of instant mix for pan cake. The variable colony count confirms high shelf life up to 3 months. In conclusion, this instant pan cake mix is a very rich source of nutrients due to the presence of finger millet as key ingredient.

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