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S Zubeda Sohan
Post Graduate & Research Centre, PJTS Agricultural University, Rajendranagar, Hyderabad, India

B Anila Kumari
Post Graduate & Research Centre, PJTS Agricultural University, Rajendranagar, Hyderabad, India

Jessie Suneetha W
Krishi Vigyan Kendra, PJTS Agricultural University, Wyra, Khammam Dist, India.

Biradar Gayatri
Department of Human Development and Family Studies, College of Community Science, PJTS Agricultural University, Saifabad, Hyderabad, India

Corresponding Author
B Anila Kumari
Post Graduate & Research Centre, PJTS Agricultural University, Rajendranagar, Hyderabad, India

Formulation and quality evaluation of millet flaked snack bar

S Zubeda Sohan, B Anila Kumari, Jessie Suneetha W and Biradar Gayatri

Abstract
The energy bar was formulated with the standardized flakes of foxtail and proso millets in different proportions along with other ingredients like jaggery, liquid glucose, skimmed milk powder, cocoa powder, dates, flax seeds, sesame seeds, groundnuts and soya granules. The nutritional analysis showed results that when compare to control bar (CNB) there was decrease in moisture (21%), protein (32.04%), fat (49.02%), ash (29.08%) and energy (7.81%) in millet bar whereas increase in crude fiber (121.42%) and carbohydrates (27.73%) was observed. Stored in LDPE pouches for 45 days of storage period. The millet bar optimized had retained their 90% organoleptic properties still 45th day of storage. The serving size of millet bar was 50g and unit cost Rs.45.00 was obtained. The energy content of MNB per serving was nearly 211.67kcal. Consumer evaluation of MNB was measured based on acceptance with 60 respondents. This survey shows that 50% of the consumers had excellent satisfaction levels, 46.7% had rated for very good on satisfaction levels, 1.7% rated good and 1.7% rated for fair. These bars can be recommended to scale them up to the industrial level.

Keywords: millet snack bar, nutritional analysis, consumer evaluation

1. Introduction
Consumers have the tendency to look for easily prepared food, such as snacks, which are defined as alternatives to quick meals with or without substantial nutritional value. According to Bower and Whitten, (2000) [10] numerous products are classified as "snacks," and in this category, mini-pizzas, cakes, popcorn, cereals, and cereal-based bars can be included. Generally, snack bars are not recognized as functional foods, mainly due to their nutrient-poor composition. In the last years, there is an interest in making new types of snack bars with functional components. Therefore, snack bars can also be included in the functional product category and to consider consumer's acceptable and suitable ready-to-eat product.
Norajit *et al.* (2011) [13] developed an energy bar with different proportions of whole hemp and defatted hempseed about 20%, 30% and 40% in rice flour. Among the three proportions 40% of defatted hemp mixture had protein-14.09%, fat-2.95% and ash-3.59% then in the 40% whole hemp mixture had protein-12.76, fat-7.54, and ash-4.67. The whole hemp with 20% mixture was organoleptic more acceptable. High antioxidant activity was in the 40% whole hemp bar. Defatted hemp bar had high humidity than the whole hemp bar in terms of moisture sorption isotherms.
Gracia, *et al.*, (2012) developed a high fiber cereal bar with microwave roasted rice bran, rice flakes and corn flakes in different composition levels and studied the physical and chemical properties. An increased in the roasted rice bran level in the formulation reduced the force of rupture and water activity, resulted in intermediate density, and caused darkening of the bars. The contents of lipid and total dietary fiber were higher in the formulation with the highest rice bran content, which was therefore considered as a functional food. The formulation containing 0.34, 0.32 and 0.34 roasted rice bran, rice flakes, and corn flakes, respectively, was the best outcome. The most accepted bar was 10.15% rice bran, 9.7% rice flakes, 10.15% corn flakes.
Sharanya and Chaturvedi, (2014) [17] developed a nutrient rich snack bar from popped amaranth seeds acacia gum, sesame, tofu, pumpkin and groundnut seeds. The snack bar had compositions of about protein -10.27gm, fat -2.6 gm, energy -340.6 kcal, crude fibre -5.7 gm, ash -.21 gm, calcium- 472.24mg and iron- 11.28 mg.
Sharma and Mridula, (2015) [16] formulated a snack bar with popped maize flour about 12–22% with the ingredients like legume grits, soy protein and varied levels of three sweeteners that were corn syrup, honey and jaggery used with 45, 50 and 55% levels.

Organoleptic evaluation showed that 17% popped corn flour and 50% jaggery was found most acceptable one. The 100 g of energy snack bar had 9.2 g fat, 12.64 g protein, 3.14 g total minerals, 158.79 mg calcium, 4.114 mg iron, 414.4kcal energy and *invitro* protein digestibility was 70.32%. The shelf life of the bar was for 90 days.

Ho *et al.* (2016) [12] formulated a snack bar with ingredients like banana, glutinous rice flour, and coconut milk. The snack bar contains 13.23% of moisture, 1.13% of ash, 6.36% of crude protein, 22.39% of crude fat, 1.16% of crude fibre, 56.89% of total carbohydrate, and 454.51 kcal of energy.

Sobana, (2017) [18] formulated a sprouted millet based snack bar with the nutritive composition of 72.5g carbohydrate, 13.7g protein, 6.1g fat, 159.5mg calcium, and 2.93mg iron which provides 400 kcal of energy per 100g. The estimated cost of bar was Rs. 44.50/- per 100 gm.

Ravindra and Sunil, (2018) developed a high energy and high fiber popped cereal based bar with sorghum, amaranthus, chickpea and cornflakes as main ingredients and with different proportions of chocolate and gulkand. The product had compositions of about protein 3.32%, carbohydrates 77.86%, fat 5.1%, crude fiber 9% and energy 386.6 kcal.

The tendency to eat more nutritious foods instead of sweet products has led to the development of different snack bar types. Since millet consumption extends beyond breakfast at any time of the day, these products have become an excellent vehicle for delivering ingredients to functional foods on the market. Millets have an increasingly important role in modern lifestyle due to the convenient forms they can use such as ready-to-eat food products, snack bars and energy bars. Thus the present study was designed to develop a healthy snack bar

2. Materials and Methods

2.1 Preparation of snack bar

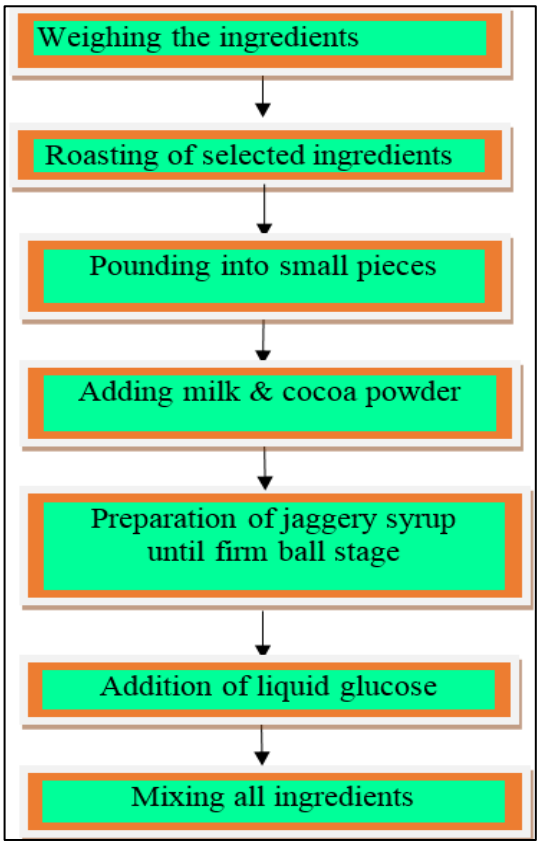

Fig 1: Flow diagram for the preparation of millet flakes incorporated bar

2.2 Proximate analysis of flakes and energy bar

The proximate composition such as moisture, total ash and protein were analysed by using standard procedure by AOAC (2005), then fat was analysed by AOAC (1997) and crude fiber by standard procedure by AOAC (1990) was analysed. The moisture content of the samples was estimated using hot air oven, fat by automatic Soxtherm extraction unit and protein by kjeldhal method. Carbohydrate content was computed by subtracting the total of moisture, ash, protein, fat and crude fibre from 100 (AOAC, 1980). Energy content was computed by multiplying protein, fat and carbohydrate values obtained from the analysis by 4, 9 and 4 respectively and expressed as Kcal / 100 g (AOAC, 1980).

2.3 Shelf-life studies of snack bars

The developed MNB was packed in LDPE pouch and stored at room temperature (37 ºC), under cool, dry conditions. Periodically at an interval of 15 days, the shelf life of the bar was assessed through sensory, free fatty acids, pH, TSS, titrable acidity and microbial analysis. Bacteria, yeast and mould content were evaluated by "standard plate count" using respective procedures, the number of colony forming units were calculated and compared with the standard permissible limits.

2.4 Consumer acceptability studies of MNB

Consumer evaluation of millet bar was done to evaluate the acceptance of the millet bar by the general population. A descriptive research design was observed for the study. A descriptive research design was chosen because the chosen study was concentrating on determining consumer preferences and accepting the behaviour of the millet bar. Descriptive Research Design scientifically involves, observing and describing the customer behaviour without influencing it in any way (Pant 2013). Sixty participants were provided with the bar for tasting and the responses were recorded in a structured questionnaire fed in Google forms.

3. Results and Discussion

3.1 Physical Characteristics of MNB: The physical characteristics such as weight, diameter, width, thickness, volume, density, spread ratio and dispersibility of the developed in millet snack bar were evaluated and presented in Table 1

Table 1: Physical parameters of millet snack bar

Physical parameters	Values
Thickness (cm)	1.30
Diameter (cm)	8.50
Width (cm)	4.50
Spread ratio	3.46
Volume (cm3)	70.87
Density (cm3)	0.70
Weight (gm)	50
Dispersibility (%)	81.50

The weight of the prepared MNB was 50g with the diameter and width of 8.5cm and 4.5cm respectively. The thickness was 1.3 cm, spread ratio was 3.46, and volume about 70.87 cm 3, and density was 0.70cm 3. The dispersibility of 81.50% showed the quick dissolution in gastric juice and easy digestion.

Proximate Composition of Millet Snack Bar: The moisture content in the prepared MNB was found to be 3.46%/ 100g, indicating low moisture content. The developed MNB provided 423.3 kcal of energy per 100g, which qualified the product as a good energy dense snack. The bar consisted of 73.55% carbohydrate, 12.34% protein, 0.31% of crude fiber and 8.85% fat. The total ash content of the bar was 1.78%/100g. The findings are in line with the results of Sobana (2017) [18] showed 6.33% of moisture in composite sports bar. The energy contribution of the developed MNB was more than the composite sports bar which provided 400 kcal.

Table 2: Proximate nutrients of millet snack bar

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	Carbohydrate (%)	Energy Kcal/100g
CMB	4.38^{a}±0.11	2.51^{a}±0.00	18.16^{a}±0.05	17.36^{a}±0.33	0.14^{b}±0.00	57.58^{b}±0.33	459.2^{a}±1.80
MNB	3.46^{b}±0.17	1.78^{b}±0.06	12.34^{b}±0.21	8.85^{b}±0.65	0.31^{a}±0.01	73.55^{a}±0.92	423.3^{b}±3.00
Mean	3.92	2.15	15.25	13.11	0.22	65.56	441.25
SE of DF	0.14	0.06	0.19	0.81	0.01	0.95	4.37
CD	0.61	0.27	0.85	3.49	0.07	4.11	18.81
CV%	4.47	3.7	1.59	7.59	8.94	1.78	1.21

Note: Values are expressed as mean ± standard deviation of three determinations
Means within the same column followed by a common letter do not differ significantly at ($p \leq 0.05$)
CMB: control bar.
MNB: Millet bar with 50% of foxtail and proso flakes

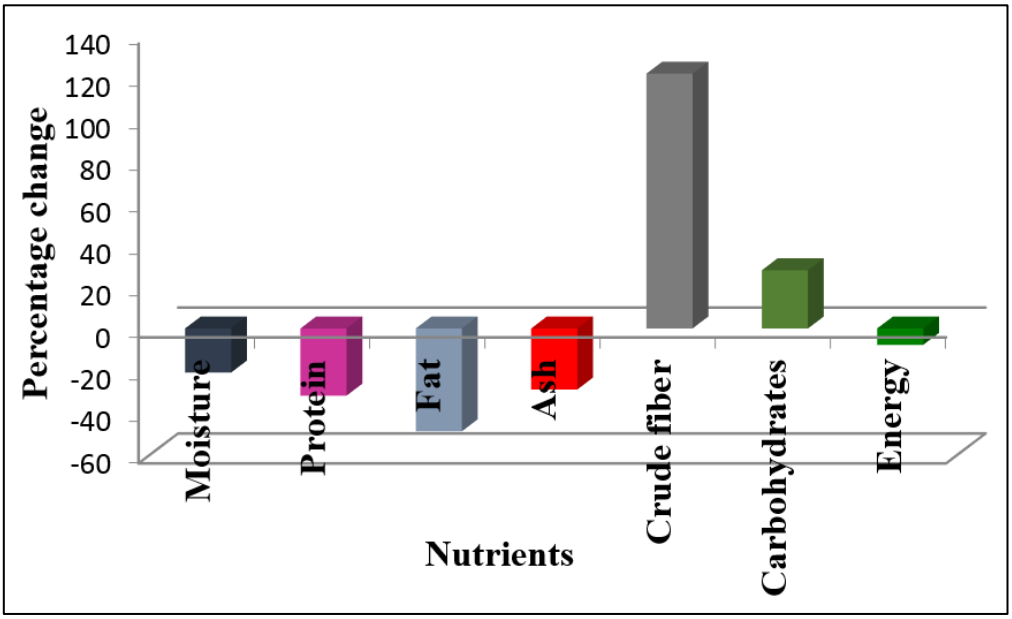

Fig 2: Percentage change in proximate nutrients of millet snack bar

3.3 Shelf life Analysis of Millet Snack bar: Storage life refers to the end of consumer acceptability and is the time at which the majority of consumers are displeased with the product. The selected experimental sample MNB was prepared and store in LDPE pouches for 45 days of storage period. The Millet bar was analyzed for its sensory parameters, TBC, TMC, TSS, pH, titrable acidity and free fatty acids during storage. The details of these parameters and Formulation and changes during storage were observed at every fifteen days intervals. The responses were analyzed and the mean value of each response variable at every fifteen days of storage.

Table 3: Microbial Formulation and of MNB during storage

Total Bacterial Count (TBC) cfu/g							
	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}
Initial day	Nil	Nil	Nil	Nil	Nil	Nil	Nil
15th day	Nil	Nil	Nil	Nil	Nil	Nil	Nil
3initialday	BDL	BDL	Nil	Nil	Nil	Nil	Nil
45th day	BDL	BDL	BDL	Nil	Nil	Nil	Nil
Total Mould Count (TMC) cfu/g							
	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}
Initial day	Nil	Nil	Nil	Nil	Nil	Nil	Nil
15th day	Nil	Nil	Nil	Nil	Nil	Nil	Nil
3initialday	Nil	Nil	Nil	Nil	Nil	Nil	Nil
45th day	BDL	BDL	BDL	BDL	Nil	Nil	Nil

Table 4: Physico-chemical properties of MNB during storage

Storage period	Titrable acidity	pH	TSS	Free fatty acids
Initial Day	$0.1^{a}\pm0.00$	$6.96^{c}\pm0.00$	$8.16^{b}\pm0.33$	$0.3^{a}\pm0.00$
15th Day	$0.1^{a}\pm0.00$	$6.86^{b}\pm0.01$	$8.15^{a}\pm0.32$	$0.3^{a}\pm0.00$
3initialDay	$0.1^{a}\pm0.00$	$6.84^{a}\pm0.01$	$8.23^{d}\pm0.21$	$0.3^{a}\pm0.01$
45th Day	$0.2^{b}\pm0.01$	$6.84^{a}\pm0.01$	$8.22^{c}\pm0.20$	$0.3^{a}\pm0.01$
Mean	0.12	6.87	8.19	0.3
SE OF DF	0	0.07	0.05	0
CD	0	0.25	0.31	0
CV	0	1.28	0.21	0

Note: Values are expressed as mean ± standard deviation of three determinations
Means within the same column followed by a common letter do not differ significantly at ($p \leq 0.05$)

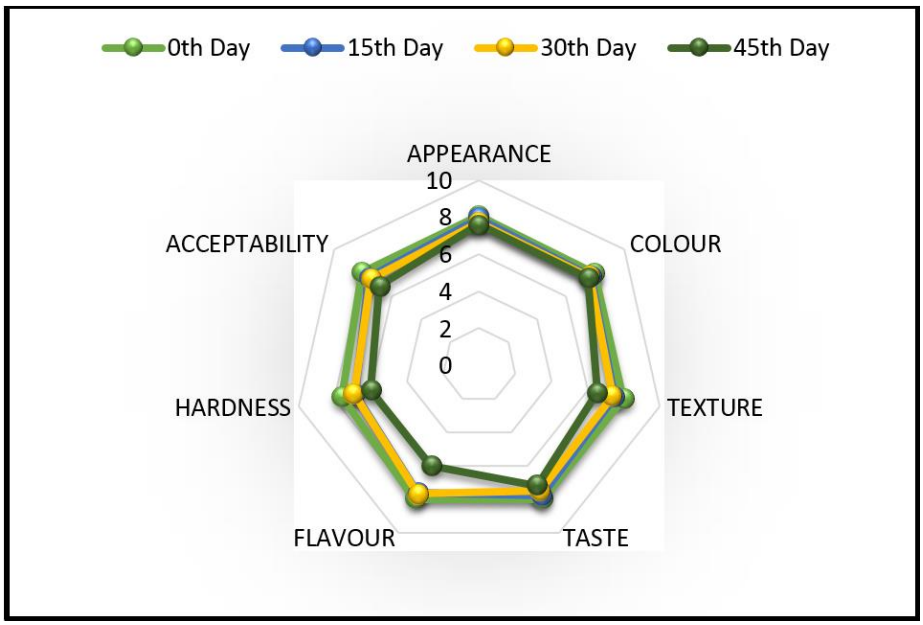

Fig 3: Sensory evaluation of MNB during storage

The Figure 3 clearly shows that there was continues change in the sensory properties of millet bar (MNB) during the storage period that is initial day, 15th day, 30th day and 45th day. The mean sensory scores for appearance were reduced from 8.06±0.11 (initial day) to 7.6±0.05 (45th day) in MNB sample. The mean sensory scores for colour were reduced from 8.00±0.09 (initial day) to 7.53±0.13 (45th day). The mean sensory scores for texture was reduced from 8.00±0.19 (initial day) to 6.53±0.13 (45th day). The mean sensory scores for flavour was reduced from 8.00±0.21 (initial day) to 7.00±0.16 (45th day) in millet bar prepared with the foxtail and proso flakes. The mean sensory scores for taste was reduced from 8.00±0.21 (initial day) to 7.20±0.14 (45th day) in the sample. The mean sensory scores for hardness was reduced from 7.60±0.25 (initial day) to 7.00±0.10 (45th day) in the millet bar sample. The mean sensory scores for overall acceptability was reduced from 8.06±0.20 (initial day) to 6.86±0.13 (45th day) in the millet bar sample.

Similar results were reported by Sobana (2017) [18] in the sports bar. The recorded results clearly show that the appearance of the composite sports bar was reduced from 8.0 (initial day) to 3.7 (90th day), colour has declined from 8.2 (initial day) to 2.3 (90th day). The mean sensory score was reduced in taste during storage studies of sports bar from 8.0 to 1.4 during initial day to 90th day period of storage. The flavour is reduced from 8.7 (initial day) to 1.9 (90th day) and the overall acceptability of composite sports bar is scored 38.3 on initial day and 13.1 on 90th day, it was reduced gradually.

4.9 Costing of the formulated product

The price of MNB was calculated based on the prevailing current price of ingredients used in formulation and processing charges for the preparation of the test mix. The cost of MNB was compared with commercially available nutrient bars and presented in Table 4. The total cost expended for the preparation of MNB was Rs.90.00 per 100g. From the total quantity of ingredients, two bars with a serving size of 50g were obtained and the unit cost was Rs.45.00 per 50g. MNB is providing 211.65 kcal/serving in Rs. 45.00. The developed millet flakes based energy bar is affordable and far more cost-effective than the commercial bars in the market.

Consumer responses on the acceptability of MNB: Randomly selected 60 consumers has tasted the product and indicated their overall liking using a 5 point hedonic scale. The scoring given for taste, appearance and overall acceptability were analyzed and presented in Figure 4 shows that 46.7% of respondents gave a score 4 (very good), 38.3% gave 5 (Excellent), 13.3% gave 3 (good) and 1.1% given score 2 (fair) for overall acceptability of MNB. This clearly shows that most consumers like the product.

In the present survey information regarding satisfaction levels after consuming the MNB were also collected**.** Figure 5 shows that about 50% of the consumers had excellent satisfaction levels, 46.7% had rated for very good on satisfaction levels, 1.7% rated good and 1.7% rated for fair on these satisfaction levels.

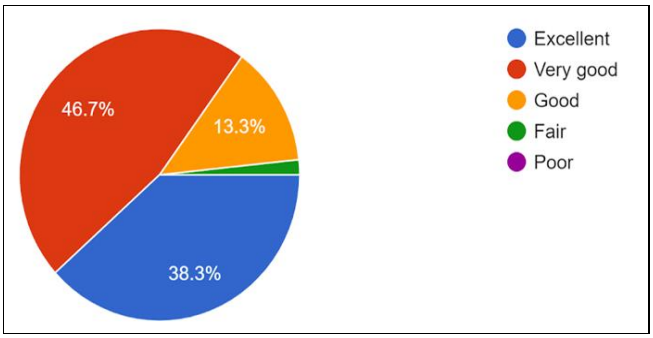

Fig 4: Consumer response for overall acceptability of MNB

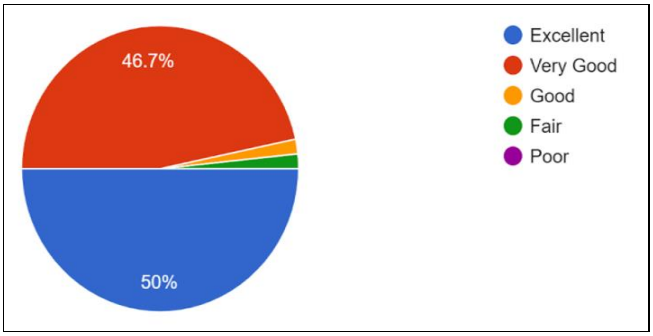

Fig 5: Consumer response on the satisfaction level of MNB

4. Conclusion

Snacks become essential and convenient foods with the nutritional requirements of contemporary life. Other than sensory characteristics, which are well accepted by consumers, their low cost, easy to carry and ready to eat made them increasingly popular. The use of foxtail and proso flakes in formulating millet bars could confer interesting Formulation and characteristics, providing modifications in the nutritional Formulation and of the various formulations. The present study was carried out on the standardization of foxtail and proso flakes and develop millet snack bar.

- Physical properties of millet bar (MNB) analyzed showed an increase was seen in thickness (8.3%), 5.48% in spread ratio, 28.38% in volume, 2.4% in diameter, 2.27% in width and 4.21% in dispersibility when compared to control bar. The decline in density (22.22%) was observed.
- The nutritional analysis showed results that when compare to control bar (CNB) there was decrease in moisture (21%), protein (32.04%), fat (49.02%), ash (29.08%) and energy (7.81%) in millet bar whereas increase in crude fiber (121.42%) and carbohydrates (27.73%) was observed.
- The millet bar was analyzed for organoleptic evaluation, TBC, TMC, TSS, pH, titrable acidity and free fatty acids during storage of millet bar for every fifteen days of interval. The titrable acidity during the storage period up to 30th day (0.1±0.0) and 45th (0.2±0.0) was observed. Total soluble solids had ranged from (8.16±0.33 to 8.23±0.20) was increased till 3initialday but a decrease in 45th day, free fatty acids had 0.3±0.01 up to 45th day of storage period and pH was observed at initial day (6.96±0.0) to 45th day (6.84±0.0).
- Total bacterial count and total mould count was observed below detectable level i.e., <300cfu/g. The millet bar optimized had retained their 90% organoleptic properties still 45th day of storage.
- The cost of millet bar was analyzed that per 100gms Rs. 90 was priced. The serving size of millet bar was 50g and unit cost Rs.45.00 was obtained.

Can be available on the market for ordinary users and scale them up to the industrial level.

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