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FORMULATION AND QUALITY EVALUATION OF CHOCOLATE FLAVOURED RICE BASED MEAL REPLACER FOR ADULTS

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ABSTRACT

This research (2021-2024) aimed to create nutritious meal replacers for adults that offer balanced nutrients. The meal replacer powder was developed using rice, ragi, and other functional ingredients at different levels (MR-T_1 to MR-T_{10}). Meal replacer powder was prepared using these treatments and subjected to organoleptic evaluation. The best treatment was selected through sensory evaluation using a scorecard with a nine-point hedonic scale. The maximum score for all the organoleptic attributes was obtained for meal replacement powder (MR-T_5), which were prepared by blending rice (50%), ragi (10%), jackfruit flour (15%), skimmed milk powder (15%), soy protein isolate (5%) and other ingredients like peanut and rice bran flour (5%). The nutritional composition of the selected meal replacement powder included 65.173g of carbohydrates, 22.88g of protein, 2.323g of fat, 4.137g of fibre, and 2.39g of total ash per 100g, offering 371.92 kcal of energy. Nutritious meal replacers made from locally sourced ingredients can be promoted as a healthy and convenient option for maintaining a balanced diet in busy lifestyles.

Keywords: Meal replacer, Nutritional qualities, Rice, Sensory qualities

INTRODUCTION

The adult population in developing countries faces significant health issues due to both underweight and rising rates of overweight and obesity. Factors such as dietary changes, urbanization, sedentary lifestyles, and improved economic conditions contribute to this trend. In India, urban areas exhibit three times the rates of overweight and obesity compared to rural areas, with women being more affected. The World Health Organization (2024) states that globally, 390 million adults are underweight, while 2.5 billion are overweight, including 890 million living with obesity.

Skipping breakfast was seen commonly in males and those between the age of 18- 34 years (Alkhulaifi and Darkoh, 2022). According to Singh (2024) every one in four urban Indian claim to skip breakfast and skipping of breakfast meal was seen across all age groups and bout 72 per cent skip by having a nutritionally inadequate breakfast meal.

The shift towards healthier lifestyles is growing among people of all ages, leading to

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a preference for nutritious, easy-to-prepare meals that are low in fat and high in nutrients. This trend has increased the demand for ready-to-use mixes, which can replace traditional meals and are becoming more popular due to rising rates of diabetes, obesity, and cardiovascular diseases. As awareness of the importance of weight management and health improves, the market for meal replacers is expanding. These products effectively curb hunger while providing essential nutrients such as fibre, vitamins, minerals, and proteins.

Meal replacers are available in various forms, including shakes, bars, and frozen entrees. They help individuals avoid the drawbacks of unhealthy, high-calorie meals, support immune function, aid in weight management, and ensure nutrient intake. However, the high cost and concerns about sugar and additives in existing meal replacement products are causing consumer hesitation. This underscores the need for innovation in convenient, healthier food options.

Meal replacers are a valuable choice for those who skip meals, working individuals, and anyone aiming for a healthier lifestyle. Therefore, this study focused on creating nutritious rice-based meal replacers for adults that deliver a well-balanced array of essential nutrients.

MATERIAL AND METHODS

Collection of materials

This study was carried out during 2021-2024 at Department of Community Science, College of Agriculture, Kerala Agricultural University, Thrissur, Kerala. Rice was the major ingredient for developing meal replacers. Other ingredients used were ragi, jackfruit flour, banana flour, skimmed milk powder and soya protein isolate. Peanut flour and rice bran flour were used as the functional ingredients at 5 per cent level. The rice was collected from farmers of Palakkad district. All the other ingredients were collected from local market.

Preparation of flours

The flours of different ingredients were prepared using standard procedures.

Preparation of rice flour

Rice flour was prepared by the method of Bangoura and Zhou (2007). After washing the rice, it is soaked in water for four hours. After draining the excess water the rice was placed in a cabinet dryer at 30°C for one hour and a half hours. Once dried, it was milled and sifted through 90 micron mesh to get the rice flour.

Preparation of ragi flour

Ragi flour was prepared by the method of Azeez *et al*. (2022). Cleaned finger millet grains were washed, drained, and dried in cabinet dryer at 40°C for 24 hours. The dried finger millet grains were milled and sieved through 90 ìm mesh to produce the flour.

Preparation of jackfruit flour

Raw jackfruit was collected from the households and the flour was prepared by modifying procedure suggested by Pandeay (2004). The raw jackfruit was washed and the bulbs and seeds were separated. After slicing the bulbs into 2.5 cm ß 1 cm, blanched in boiling water for 1 minute, cooled and immersed in 0.2 per cent KMS solution for 10 minutes. After draining the slices dried in a cabinet drier at 60Ú C for 12 hours. The dried chips were milled into flour and sieved through 90 mm mesh.

Preparation of banana flour

The banana was peeled and sliced into circular shape of 4 mm thickness using dicer. The slices were immersed in water (1: 3 ratio) containing 0.05% potassium meta bisulphite (K2S2O5) and 0.1 per cent citric acid for 10

minutes to arrest the enzymatic browning as suggested by Kumar *et al.* (2018). The banana slices were then dehydrated at a temperature of 55 ± 2 °C using laboratory scale hot air forced electrical convection drier, till the slices turned brittle. The dehydrated slices were ground in a commercial pulveriser for 2 minutes and then sieved using 90 micron mesh to get the flour.

Standardisation of meal replacers

Meal replacers were prepared using rice as main ingredient and ragi along with other ingredients in different combinations.

The amount of ingredients used in the treatments follows; rice 40 to 60 percent, ragi 0 to 20 per cent, and banana and jackfruit flour from 0 to 15 per cent. Skimmed milk powder 15 per cent, soya protein isolate andother ingredients (peanut flour and rice bran flour) at 5 per cent were used in all treatments at a fixed rate. The meal replacer was developed by combining the different flours in the above mentioned ratios, roasted for 5 minutes, pulverised, and sifted through a 90 micron mesh as detailed in figure 1. Later it was flavoured with chocolate at the rate of 4 per cent. The details of treatments used to standardise the meal replacers are given in Table 1.

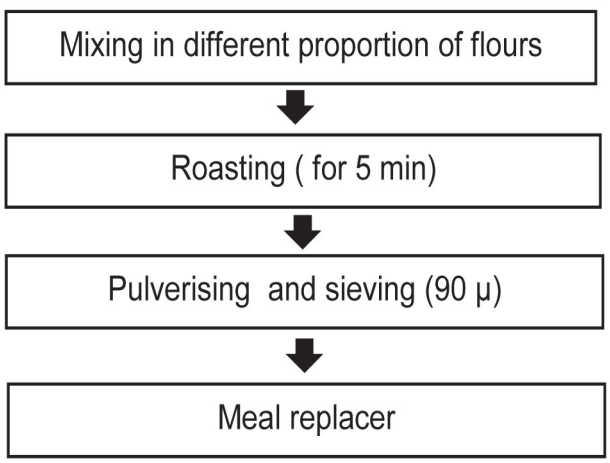

Figure 1: Preparation of meal replacers by roasting

Organoleptic evaluation

The developed meal replacer powder, 100g was diluted with 300ml of luke warm water for carrying out the organoleptic evaluation.

The sensory evaluation was carried out using score card of nine point hedonic scale by a panel of 20 judges for qualities like appearance, colour, flavour, consistency, taste and overall acceptability. The panel of twenty judges between age group of 18 to 35 years was selected by conducting a series of organoleptic trialsusing simple triangle test at laboratory level as suggested by Jellinek (1985).

Based on theorganoleptic scores the best combination of meal replacer was selected and nutritional evaluation were carried out.

Nutritional composition

The nutritional qualities like moisture (A.O.A.C. 1980), carbohydrate, protein, fat and fibre (Sadasivam and Manickam,1997) contents and energy value of the selected meal replacer were determined.

Statistical analysis

The statistical analysis was carried out for the mean score obtained from sensory evaluation.The data on organoleptic evaluation was statistically interpreted using Kendall Coefficient of concordance. Standard deviation was carried out for nutritional analysis.

Cost of production of meal replacement powder.

The costof production of the most acceptable meal replacement powder was computedbased on the market price of ingredients used for its preparation.

Labour charge, fuel charge, electricity charge and packaging cost incurred was also taken into consideration while computing the cost.The cost was calculated for100g ofthe

Table 1:Standardisation of meal replacers with chocolate flavour

Treatments	Combinations	Chocolate flavour
MR-T_1	40% R + 20% MR + 15% SMP + 5% SPI + 15% BF + 5% OI	
MR-T_2	40% R + 20% MR + 15 % SMP + 5% SPI + 15% JF + 5% OI	
MR-T_3	40% R + 20% MR + 15 % SMP + 5% SPI + 15% (BF+JF) + 5% OI	
MR-T_4	50% R + 10% MR + 15 % SMP + 5% SPI + 15% BF + 5% OI	**4 %**
MR-T_5	50% R + 10% MR + 15 % SMP + 5% SPI + 15% JF + 5% OI	**chocolate**
MR-T_6	50% R + 10% MR + 15 % SMP + 5% SPI + 15% (BF+JF) + 5% OI	**powder**
MR-T_7	60% R + 15 % SMP + 5% SPI + 15% BF + 5% OI	
MR-T_8	60% R + 15 % SMP + 5% SPI + 15% JF + 5% OI	
MR-T_9	60% R + 15 % SMP + 5% SPI + 15% (BF+JF) + 5% OI	
MR-T_{10}	60% R + 15% MR + 15 % SMP + 5% SPI + 5% OI	

(R- rice, MR- millet ragi, SMP- skimmed milk powder, SPI-soy protein isolate, OI-other ingredients)

Table 2: Mean score for organoleptic qualities of meal replacers (MR) with chocolate flavour

Treatments	Sensory parameters						
	Appearance	Colour	Flavour	Consistency	Taste	Overall Acceptability	Total mean score
MR-T_1	8.41(5.35)	8.41(5.35)	7.77(3.83)	7.83(2.86)	7.31(2.18)	7.76(3.30)	7.91
MR-T_2	8.43(5.68)	8.45(5.95)	7.9(4.18)	7.91(3.76)	7.78(3.85)	7.9(4.35)	8.06
MR-T_3	8.4(5.08)	8.43(5.80)	7.82(3.55)	7.86(3.26)	7.51(2.88)	7.83(3.38)	7.97
MR-T_4	8.42(5.65)	8.42(5.70)	8.42(7.08)	8.43(7.19)	8.38(6.53)	8.36(6.75)	8.40
MR-T_5	8.48(6.45)	8.46(6.05)	8.46(7.70)	8.49(7.48)	8.45(7.13)	8.46(7.58)	8.46
MR-T_6	8.46(6.28)	8.43(5.80)	8.44(7.38)	8.45(7.45)	8.41(6.63)	8.43(7.25)	8.43
MR-T_7	8.42(5.65)	8.4(5.30)	8.19(4.48)	8.01(5.52)	8.18(5.43)	8.06(5.35)	8.21
MR-T_8	8.44(5.93)	8.41(5.35)	8.30(5.83)	8.23(6.21)	8.23(8.30)	8.28(6.75)	8.31
MR-T_9	8.42(5.65)	8.4(5.30)	8.23(5.68)	8.21(5.83)	8.21(6.25)	8.16(5.68)	8.27
MR-T_{10}	8.44(5.93)	8.41(5.35)	8.14(5.33)	8.08(5.43)	8.06(5.85)	7.91(4.63)	8.17
Kendall"s W	0.061*	0.017*	0.278**	0.352*8	0.448**	0.306**	

Value in paranthesesare mean rank score based on Kendall's W

**Significant at 1 % level, *significance at 5 % level

product and compared with similar products available in the market.

RESULT AND DISCUSSION

Organoleptic qualities of rice based meal replacers with chocolate flavour

The mean score and the mean rank scores obtained for different sensory attributes of meal replacers prepared with different combination of ingredients arepresentedin Table2.

The mean score for appearance of meal replacers prepared in different combinations (MR-T_1 to MR-T_{10}) ranged from 8.41 to 8.48. For colour and flavour, the mean score varied from 8.41 to 8.46 and 7.77 to 8.46 respectively. As the product was flavoured with 4 per cent of 100 per cent cocoa powder, all treatments had almost similar appearance and colour. Considerable difference in flavour was noticed with change in ingredients and treatments added with banana flour had lowest scores for flavour. Mean score for consistency of different treatments was between 7.83 to 8.49. The mean scores for taste varied from 7.31 to 8.45 and maximum mean score for taste was noticed for treatments added with jackfruit flour. For overall acceptability the scores ranged from 7.91to 8.46. Among the meal replacers, the highest mean score of 8.48, 8.46, 8.46, 8.49, 8.45 and 8.46 for appearance, colour, flavour, consistency, taste and overall acceptability respectively was noticed for treatment MR-T_5 (50 per cent rice, 10 per cent ragi, 15 per cent jackfruit flour, 15 per cent skimmed milk powder, 5 per cent soy protein isolate and 5 per cent other ingredients like peanut and rice bran flour) and it was selected for further studies. Based on Kendall's coefficient of concordance, significant agreement among judges was observed while determining the organoleptic qualities.

Meal replacers prepared with various combinations were generally acceptable in terms of organoleptic qualities. However, combinations including ragi flour and banana flour were less well-received, particularly in terms of flavor, texture, and taste. Adding more than 10% ragi flour negatively impacted the color and taste of the products, consistent with findings by Bansal and Kaur (2018), who reported reduced acceptance for milk beverages containing 15% ragi. Higher concentrations of ragi flour resulted in a slightly bitter taste (Taynath *et al.,* 2018), while banana flour contributed a slight astringency due to tannins and polyphenols (Sruthy *et al.,* 2020). In contrast, meal replacers containing jackfruit flour were the most accepted, as jackfruit flour added a subtle sweetness and slightly dense texture, enhancing overall taste, as noted by Soumya and Divakar (2021).

Nutritional qualities of rice basedmeal replacer

The prepared meal replacer powder was evaluated for nutritional qualities like moisture, energy, carbohydrate, protein, fat, and fibre(Table:3).

The rice-based meal replacer contained 3.03% moisture, 65.17g of carbohydrates, 22.88g of protein, 2.32g of fat, 4.13g of fibre, 2.39g of total ash, and 371.92 Kcal of energy per 100g. These values are similar to those found in germinated wheat and mung bean-based weaning food mixes, which have moisture levels of 3.30 to 3.70%, carbohydrates ranging from 52.80 to 61.20g, protein from 20.80 to 27.70g, fibre from 3.10 to 3.50g, ash from 2.08 to 2.36g, and energy from 411.40 to 419.30 Kcal per 100g, as reported by Jahan *et al.* (2021). Our results are consistent with findings from Mandal and Antarkar (2024) who reported that millet based wafer premixes developed using ingredients like finger millet flour (30%), rice flour (20%), milk powder (14%), sugar (30%), cocoa powder (5%). These premixes have a moisture content of 5.76%, 68.29 g of carbohydrates, 9.61 g of protein, and 0.74 g of fat. Similarly, Wandhekar *et al.* (2021) developed an instant appe mix

Table 3: Nutrient analysis of selected meal replacer

Nutrients (100 g^{-1})	T_5
Moisture (%)	3.303 ±0.005
Energy (Kcal)	371.92±0.100
Carbohydrate (g)	65.173±0.010
Protein (g)	22.883±0.010
Fat (g)	2.323±0.002
Crude fibre (%)	4.137±0.001
Total ash	2.397±0.002

(MR-T_5 =50 per cent rice, 10 per cent ragi, 15 per cent jackfruit flour, 15 per cent skimmed milk powder, 5 per cent soy protein isolate and 5 per cent other ingredients like peanut and rice bran flour)

by combining rice, black gram, finger millet, and foxtail millet in a proportion of 40:20:20:20. The resulting mix exhibited a moisture content of 5.51%, with 72.4% carbohydrates, 12.04% protein, 1.46% fat, 3.4% crude fiber, and 1.57% ash.

A meal replacement product should provide 200 to 400 kcal per serving as it used for replacing major meals (codex standards). The developed meal replacer could meet the specified requirements for such a product providing a balanced ratio of different nutrients.

Cost of production of meal replacement powder

The cost of production of meal replacement powder was Rs. 200/kg and was found to be much lower in price compared to such products available in the market. So the developed meal replacement powder offers affordability without sacrificing nutritional quality for consumers.

CONCLUSIONS

Rice based meal replacer powder is a nutrient-dense, cost effective alternative for dietary management and convenience. The formulation containing 50% rice, 10% ragi, 15% jackfruit flour, 15% skimmed milk powder, 5% soy protein isolate, and 5% peanut and rice bran flour (MR-T5) was found to have high acceptability, achieving excellent sensory scores in appearance, color, flavor, consistency, taste, and overall acceptability. Nutritional analysis revealed that MR-T5 provides 65.17g carbohydrates, 22.88g protein, 2.32g fat, 4.13g fiber and 371.92 Kcal per 100g, making it a balanced and effective meal replacement.

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