



# A Study on Storage Stability of Brown Rice-Based Instant *Khichdi* Mix

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

The objective of the current research was to formulate the instant *khichdi* mix from processed brown rice (IBR) and dehulled mungbean (IDM) and to evaluate its minerals, bioactive components, microbiological and organoleptic parameters during storage of 90 days. Six composite instant *khichdi* mixes were formulated by taking different proportions of processed brown rice and dehulled mungbean in the ratios of T<sub>1</sub> (100:00::IBR:IDM), T<sub>2</sub> (90:10::IBR:IDM), T<sub>3</sub> (80:20::IBR:IDM), T<sub>4</sub> (70:30::IBR:IDM), T<sub>5</sub> (60:40::IBR:IDM) and T<sub>6</sub> (50:50::IBR:IDM). The prepared instant *khichdi* mix was packed in aluminum laminates and stored under ambient conditions (32±2°C) for a period of 90 days. Results revealed that iron, calcium and potassium showed an increasing trend from 3.53 to 5.50, 26.65 to 67.82 and 256.40 to 700.68 mg per 100 g, respectively with the incorporation of processed dehulled mungbean. The maximum mean total phenolic content of 165.89 mg GAE per 100 g was recorded in treatment T<sub>6</sub> (50:50::IBR:IDM). However, the maximum mean antioxidant

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activity of 46.12 per cent was recorded in treatment T<sub>1</sub> (100:00::IBR:IDM). Sensory evaluation revealed that the highest mean overall acceptability scores of 7.91 was recorded in T<sub>5</sub> (60:40::IBR:IDM) which was adjudged as superior among all the treatments of instant *khichdi* mix. The formulated instant *khichdi* mix retained its quality throughout the storage period of 90 days with total microbial count within safe limits.

**Keywords:** Instant *Khichdi*-mix; brown rice; dehulled mungbean; nutrient composition; microbial count.

## 1. INTRODUCTION

Convenience foods are a class of foods that impart convenience to the consumers by way of little or no requirements of major processing or cooking before their consumption. These foods require minimum handling, such as mild heating/warming for ready-to-eat products or rehydration in hot/cold water for dehydrated foods. Nutritionally rich convenience food formulations will have a definite uprising and fulfill the market demands. In India, the majority of food is consumed at home, but food consumption outside the home has increased due to the increase in urbanization, changing lifestyle, increasing working women and less time to cook which increased the need for convenience foods [1]. The requirement for ready-to-serve/instant foods has further gained importance in the light of the COVID-19 pandemic, as they provide not only an easy solution to minimize handling and contact-free delivery of food but also are a lunch option alternative for individuals who would have normally fed at restaurants that were largely shut down during the pandemic [2].

*Khichdi* is a convenient food which termed as super food because it contains very high nutritional density. In Ayurveda, *khichdi* is classified as 'Sattvic' food. This means that it nourishes, purifies and strengthens both the body and mind [3]. *Khichdi* is a dish from Indian subcontinent made with a mixture of rice and legumes which is loaded with wholesome goodness, easy to digest and free of gluten, but the process is slightly time consuming [4]. However, the process of making *khichdi*, using the instant mix involves bringing to boil the appropriate quantity of water, adding the mix to it and lightly heating. Due to the ease in cooking, saving in time and labour, it provides convenience to consumers [5].

Brown rice is whole grain rice with intact bran layer and the inedible outer hull removed. It is the unmilled rice containing the pericarp, the seed coat and nucellus, the germ or embryo and the endosperm [6]. The nutritious, high fibre bran coating gives it a light tan colour, nut like flavour

and chewy texture. The nutritional components in brown rice mainly exist in the germ and bran layers, which are mostly removed by polishing as an outcome [7]. It has a low glycemic index which indicate low digestibility of starch. Brown rice is an excellent source of functional components, bioactive components, vitamins and minerals [8]. Thus, the utilization of brown rice in convenience foods could be a good strategy to exploit its nutritional value and also take out the burden of long cooking time [9].

Mungbeans are a small, oval type of green bean that is high in fibre and when the bean is split in half it is referred to as dehulled mungbean or moong dal. Mungbean is the seed of *Vigna radiata* and is native to the Indian subcontinent [10]. The bean is green with the husk and yellow when dehusked. Mungbeans are a high source of nutrients including manganese, potassium, folate, copper, zinc, magnesium and various B vitamins. They are also high in resistant starch, dietary fibre, protein and amino acid especially lysine and thus can supplement cereal based human diets [11]. Mungbean is also an excellent source of phenolics, flavonoids and other antioxidants [12]. In addition, mungbean is lower in phytic acid than pigeon pea, soybean and cereals. Because of their high nutrient density, they are considered useful in defending against several chronic and age-related diseases [10].

Brown rice and dehulled mungbean are considered as an excellent source of functional components which contains important nutrients such as bioactive components, B-complex vitamins, dietary fibre and minerals which can provide and promote human health. So, they can be processed into further forms to utilize them in the preparation of various value-added food products.

## 2. MATERIALS AND METHODS

### 2.1 Procurement of Raw Materials

Brown rice was purchased from Jatinder Rice Mill, R.S. Pura, Jammu. Dehulled mungbean was purchased from local market of Jammu and used for experimentation. The basic raw materials used for the preparation of instant *khichdi* were

brown rice, dehulled mungbean, garlic, ginger, onion, potato along with spices and salt. All the raw materials were transported to pilot plant of Division of Food Science and Technology, SKUAST-Jammu for further processing.

## 2.2 Sample Preparation

### 2.2.1 Processing of brown rice and dehulled mungbean

The procured brown rice grains were cleaned manually and soaked in water at room temperature for 3 hours. After that, the samples were drained and cooked in pressure cooker [13] followed by microwave drying. The procured dehulled mungbean was cleaned manually and soaked in water at room temperature. After that, dehulled mungbean was drained and cooked in pressure cooker [5]. After cooking, rice and dal was subjected to microwave drying. For microwave drying, cooked brown rice and dehulled mungbean were frozen at  $-20^{\circ}\text{C}$  for 24 hours. The frozen brown rice and dehulled mungbean were then thawed and placed inside the microwave oven in the form of a thin layer on rotating glass plate with a diameter of 400 mm and dried at 900 W till the required moisture content (below 10%) was achieved. Moisture loss of the sample was recorded at 5-minute interval using an electronic moisture analyzer (Citizen MB 50C). The dried brown rice and dehulled mungbean obtained from microwave drying were packed separately in air tight containers for further use.

### 2.2.2 Instant vegetables (onion, potato, ginger and garlic)

Healthy vegetables (onion, potato, ginger and garlic) were selected and blanched at  $95^{\circ}\text{C}$  for 2-3 minutes followed by cooling and surface drying at room temperature. After blanching, all the vegetables were subjected to hot air drying at  $60^{\circ}\text{C}$  [14] until the required moisture content was achieved. The dried vegetables were packed in air tight containers and stored for further use.

## 2.3 Formulation of Instant *Khichdi* Mix

For formulation of instant *khichdi* mix, instant brown rice and instant dehulled mungbean were mixed together in different proportions to make six treatment combinations viz.,  $T_1$  (100:00::IBR:IDM),  $T_2$  (90:10::IBR:IDM),  $T_3$  (80:20::IBR:IDM),  $T_4$  (70:30::IBR:IDM),  $T_5$  (60:40::IBR:IDM) and  $T_6$  (50:50::IBR:IDM). The instant *khichdi* mix was prepared from instant brown rice, dehulled mungbean, vegetables and

spice mixture as per the procedure given by Durgarao [5] with slight modifications. Six composite instant *khichdi* mixes were formulated along with other ingredients including dried garlic, onion flakes, potato cubes and spice mixture.

## 2.4 Storage

The prepared instant *khichdi* mix was packed in aluminum laminates, sealed and stored under ambient conditions ( $32\pm 2^{\circ}\text{C}$ ) for a period of 90 days. The samples were analyzed periodically at an interval of 0, 30, 60 and 90 days of storage for minerals, bioactive, microbiological and organoleptic characteristics.

## 2.5 Chemical Analysis

### 2.5.1 Minerals

The mineral contents were determined after the ash determination. The ash residue of each formulation was digested with perchloric acid and nitric acid (1:4) solution [15]. The samples were left to cool and contents were filtered through Whatman filter paper no. 42. Each sample solution was made upto a final volume of 25 ml with distilled water. The aliquot was used separately to determine the mineral content of iron, calcium, potassium and magnesium by using an Atomic Absorption spectrophotometer (Spectra AA 220, USA Varian).

### 2.5.2 Bioactive components

#### 2.5.2.1 Total phenolic content

Homogenized sample (1 g) was extracted three times with 80 per cent methanol. The extracts were digested with perchloric acid and nitric acid (1:4) solution [16]. The samples were left to cool and contents were filtered through Whatman filter paper no. 42. Each sample solution was made upto a final volume of 25 ml with distilled water. The aliquot was used separately to determine the mineral content of iron, calcium, potassium and magnesium by using an Atomic Absorption spectrophotometer (Spectra AA 220, USA Varian).

#### 2.5.2.2 Antioxidant activity

Antioxidant activity of samples was determined by DPPH (1,1, diphenyl - 2 picrylhydrazyl) method. Five hundred micro liters of 0.5 Mm DPPH solution and 2 ml of 80 per cent methanol aqueous solution were mixed with 25  $\mu\text{l}$  of methanolic extract of sample, and absorbance was determined at 517 nm using blank as 80 per cent methanol and tris buffer after maintaining at

20°C for 30 minutes. The free radical scavenging activity was evaluated by comparing the absorbance of the sample solution with control solution to which distilled water was added instead of sample [17].

$$\text{Antioxidant activity (\%)} = \frac{\text{Control OD (0 min.)} - \text{Sample OD (30 min.)}}{\text{Control OD (0 min.)}} \times 100$$

### 2.5.3 Microbiological analysis (Total microbial count)

Spread plate technique, described by Palczar and Chan [18] was followed. One gram of sample was aseptically transferred into test tube containing 9 ml of sterile water and was mixed vigorously. After mixing, 1 ml of this mixture was again transferred to a test tube containing 9 ml sterile water for further dilution. The process was continued until 4<sup>th</sup> diluents (10<sup>4</sup>). Plate count agar media was inoculated with 0.1 ml of diluted sample (10<sup>4</sup>), by spread plating technique and incubated at 37°C for 24 hours. Colonies were counted and multiplied by dilution factor.

### 2.5.4 Sensory evaluation

The samples were analyzed for overall acceptability on the basis of colour, taste and texture and by semi-trained panel (9-10 judges) using 9 point hedonic scale assigning scores 9-like extremely to 1-dislike extremely. A score of 5.5 and above was considered acceptable [19].

### 2.5.5 Statistical analysis

All the experiments were performed in triplicates and the data is expressed as the mean values  $\pm$  standard deviation derived from triplicate determination values. The statistical analysis of the experimental data was done by using the software IBM SPSS Statistics 26.0.

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of Treatment and Storage on Mineral Content of Instant *Khichdi* Mix

Brown rice and dehulled mungbean are good sources of minerals which are present in varied amounts. The mean iron, calcium and potassium content were found to be higher in instant *khichdi* mix formulated from higher levels of instant dehulled mungbean in contrast to instant *khichdi* mix formulated from instant brown rice (Table 1 and Fig. 1). The highest mean iron, calcium and

potassium content of 5.50 mg per 100 g, 67.82 mg per 100 g and 700.68 mg per 100 g were recorded in treatment T<sub>6</sub> (50:50::IBR:IDM), whereas the lowest mean iron, calcium and potassium content of 3.53 mg per 100 g, 26.65 mg per 100 g and 256.40 mg per 100 g were recorded in treatment T<sub>1</sub> (100:00::IBR:IDM), respectively. The increase in iron, calcium and potassium content among treatments might be due to higher iron, calcium and potassium content in instant dehulled mungbean. The results are in good agreement with Joshi and Srivastava [20] in rice and millet based *khichdi*, Rana et al. [21] in cereal and legume based *dalia* mix, and Khandekar et al. [22] in rice and legume based *khichdi*.

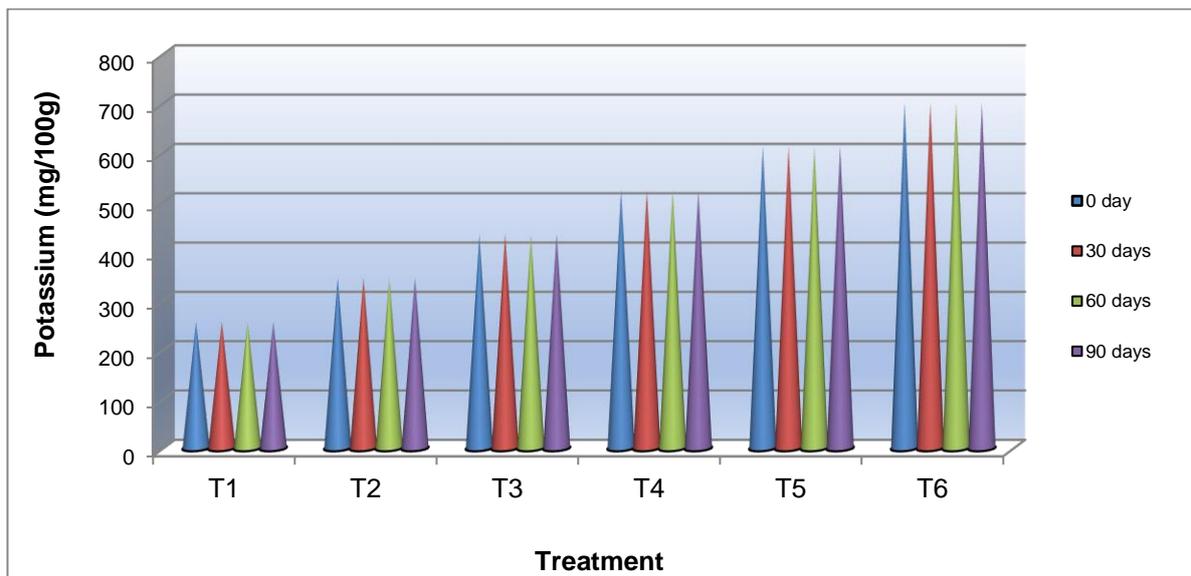
During storage period of 90 days, minerals (iron, calcium and potassium) decreased significantly from 4.59 to 4.42, 47.31 to 47.13 and 478.70 to 478.40 mg per 100g, respectively. The decrease in minerals might be due to the interaction between minerals and other compounds like carbohydrates and proteins (product of Maillard reaction) thus reducing the bioavailability of minerals [23]. Similar findings have been reported by Rokhsana et al. [24] in legume and vegetable based soup mix and Zeb et al. [25] in rice and mungbean based complementary food mix.

### 3.2 Effect of Treatment and Storage Intervals on Bioactive Components of Instant *Khichdi* Mix

On analysing the total phenolic content in instant *khichdi* mix (Fig. 2), the lowest mean total phenolic content of 53.37 mg GAE per 100 g was recorded in T<sub>1</sub> (100:00::IBR:IDM) whereas, treatment T<sub>6</sub> (50:50::IBR:IDM) recorded highest mean total phenolic content of 165.89 mg GAE per 100 g. There was significant increase in total phenolic content among the treatments which might be due to the higher total phenolic content possessed by instant dehulled mungbean. The results have been supported by the findings of Murugkar et al. [26] in cereals and legume based multi nutrient mixes and Jan et al. [27] in weaning food mix prepared from locally available raw materials. The mean total phenolic content decreased significantly from 109.87 to 109.31 mg GAE per 100 g during storage period of 90 days which might be due to the volatile nature of phenolic compounds which get easily oxidized or could also be due to their involvement in the formation of polymeric compounds,

**Table 1. Effect of treatment and storage on iron and calcium content (mg/100g) of instant *khichdi* mix**

Treatment	Iron (mg/100g)				Mean (Treatment)	Calcium (mg/100g)				Mean(Treatment)
	Storage period (days)					Storage period (days)				
	0	30	60	90		0	30	60	90	
T <sub>1</sub> (100:00::IBR:IDM)	3.60	3.56	3.51	3.44	<b>3.53</b>	26.73	26.68	26.62	26.55	<b>26.65</b>
T <sub>2</sub> (90:10::IBR:IDM)	3.97	3.92	3.86	3.81	<b>3.89</b>	34.95	34.89	34.83	34.76	<b>34.86</b>
T <sub>3</sub> (80:20::IBR:IDM)	4.38	4.34	4.28	4.21	<b>4.30</b>	43.21	43.16	43.10	43.04	<b>43.13</b>
T <sub>4</sub> (70:30::IBR:IDM)	4.79	4.73	4.67	4.60	<b>4.70</b>	51.42	51.38	51.32	51.27	<b>51.35</b>
T <sub>5</sub> (60:40::IBR:IDM)	5.20	5.15	5.09	5.02	<b>5.12</b>	59.64	59.59	59.53	59.46	<b>59.56</b>
T <sub>6</sub> (50:40::IBR:IDM)	5.58	5.52	5.47	5.41	<b>5.50</b>	67.90	67.85	67.79	67.72	<b>67.82</b>
<b>Mean (Storage)</b>	<b>4.59</b>	<b>4.54</b>	<b>4.48</b>	<b>4.42</b>		<b>47.31</b>	<b>47.26</b>	<b>47.20</b>	<b>47.13</b>	
<b>Effects</b>	<b>C.D<sub>(p≤0.05)</sub></b>				<b>Effects</b>	<b>C.D<sub>(p≤0.05)</sub></b>				
Treatment (T)	0.03				Treatment (T)	0.15				
Storage (S)	0.03				Storage (S)	0.12				
Treatment x Storage	N.S.				Treatment x Storage	N.S.				



**Fig. 1. Effect of treatment and storage intervals on potassium content (mg/100g) of instant *khichdi* mix**

complexing of phenols with proteins and their subsequent precipitation during storage [28]. Similar results have been reported by Oboh and Amusan (2009) in cereal gruels produced from maize and sorghum, Slathia et al. [29] in mungbean based noodles and Jan et al. [27] in weaning food mix prepared from brown rice and mungbean during 6 months of storage period.

Antioxidant activity is an important component that scavenges free radicals which cause degenerative diseases. The maximum mean antioxidant activity of 46.12 per cent was recorded in treatment T<sub>1</sub> (100:00::IBR:IDM) whereas, the minimum mean antioxidant activity of 31.54 per cent was recorded in treatment T<sub>6</sub> (50:50::IBR:IDM) (Table 2). There were significant differences among treatments with respect to antioxidant activity which might be due

to variation in composition of brown rice and dehulled mungbean. Similar results have been reported by Murugkar et al. [26] in cereals and legume based multi nutrient mixes and Slathia et al. [29] in mungbean based noodles.

The mean value of antioxidant activity decreased significantly from 39.07 to 38.51 per cent during 90 days of storage period. Phenolic compounds have been responsible for the antioxidant activity. Therefore, the loss in antioxidant activity could be attributed to oxidation and loss of phenolic compounds with passage of time [30]. Similar decrease in antioxidant activity have been reported by Jan et al. [27] in weaning food mix prepared from brown rice and mungbean during 6 months of storage period and Joshi et al. [31] in vegetable leaf powder soup mixes with the increase in storage period.

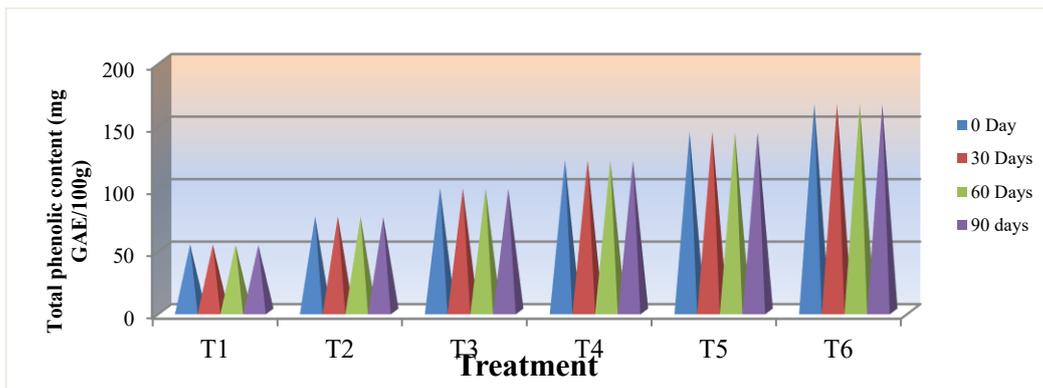


Fig. 2. Effect of treatment and storage intervals on total phenolic content (mg GAE/100g) of instant *khichdi* mix

Table 2. Effect of treatment and storage on antioxidant activity (%) of instant *khichdi* mix

Treatment	Antioxidant activity (%)				Mean (Treatment)
	Storage period (days)				
	0	30	60	90	
T <sub>1</sub> (100:00::IBR:IDM)	46.35	46.24	46.08	45.79	46.12
T <sub>2</sub> (90:10:: IBR:IDM)	43.42	43.28	43.12	42.83	43.16
T <sub>3</sub> (80:20:: IBR:IDM)	40.51	40.39	40.24	39.97	40.28
T <sub>4</sub> (70:30:: IBR:IDM)	37.63	37.51	37.33	37.05	37.38
T <sub>5</sub> (60:40:: IBR:IDM)	34.70	34.58	34.42	34.16	34.47
T <sub>6</sub> (50:50:: IBR:IDM)	31.78	31.64	31.50	31.23	31.54
<b>Mean (Storage)</b>	<b>39.07</b>	<b>38.94</b>	<b>38.78</b>	<b>38.51</b>	
<b>Effects</b>	<b>C.D<sub>(p&lt;0.05)</sub></b>				
Treatment (T)	0.06				
Storage (S)	0.05				
Treatment x Storage	0.12				

### 3.3 Effect of Treatment and Storage on Microbiological Analysis of Instant *Khichdi* Mix

Initially no microbial growth was observed upto 30 days of storage (Table 3). The highest mean total microbial count of  $0.90 \times 10^4$  cfu per g was recorded in T<sub>6</sub> (50:50::IBR:IDM), whereas lowest mean total microbial count of  $0.56 \times 10^4$  cfu per g was recorded in T<sub>1</sub> (100:00::IBR:IDM). The increase in total microbial count among treatments might be due to increasing proportion of instant dehulled mungbean which possessed higher moisture content [32]. However, the values obtained for instant *khichdi* mix were within the acceptable BIS (Bureau of Indian Standards) limits and recommendations for products of this nature ( $4 \times 10^4$  cfu per g) [1]. Similar results have been reported by Munasinghe et al. [33] in yoghurt-based weaning food, Sharma [34] in maize based convenience foods and Monika [1] in instant rice and rajmash blended convenient mix.

The total microbial count showed an increasing trend during 90 days of storage period which might be due to increase in moisture content of instant *khichdi* mix that provides favourable environment for microbial growth during storage

[35]. Munasinghe et al. [33] also reported an increase in microbial load during storage of brown rice, mungbean and soybean blended weaning food, Yadav et al. [36] in bengal gram (*Cicer arietinum*) based spiced snacks during storage period of 4 months and Durgarao [5] in instant *khichdi* during storage period of 45 days.

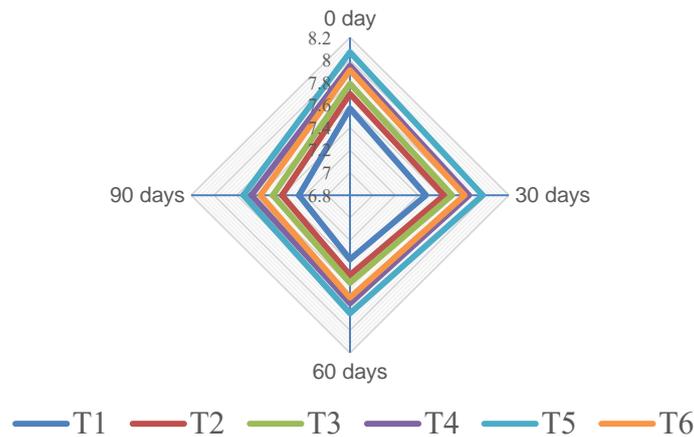
### 3.4 Effect of treatment and storage intervals on overall acceptability of instant *khichdi* mix

With the addition of 40 per cent instant dehulled mungbean, the mean scores for overall acceptability increased from 7.42 to 7.91, respectively, whereas, addition of instant dehulled mungbean beyond 40 per cent resulted in decreasing trend of overall acceptability (Fig. 3). Among all the treatments, the overall acceptability scores were rated highest in T<sub>5</sub> (60:40:: IBR:IDM) with mean score of 7.91.

Significant decrease in overall acceptability score was observed with the progress in storage period. The interaction between treatment and storage was found to be significant at 5 per cent level of significance. The decrease in sensory scores for different characteristics of the product, irrespective of treatments during storage

**Table 3. Effect of treatment and storage on total microbial count ( $\times 10^4$  c.f.u/g) of instant *khichdi* mix**

Treatment	Total microbial count ( $\times 10^4$ c.f.u/g)				Mean (Treatment)
	Storage period (days)				
	0	30	60	90	
T <sub>1</sub> (100:00::IBR:IDM)	ND	ND	0.38	0.73	<b>0.56</b>
T <sub>2</sub> (90:10::IBR:IDM)	ND	ND	0.45	0.81	<b>0.63</b>
T <sub>3</sub> (80:20::IBR:IDM)	ND	ND	0.53	0.86	<b>0.70</b>
T <sub>4</sub> (70:30::IBR:IDM)	ND	ND	0.60	0.92	<b>0.76</b>
T <sub>5</sub> (60:40::IBR:IDM)	ND	ND	0.67	0.99	<b>0.83</b>
T <sub>6</sub> (50:50::IBR:IDM)	ND	ND	0.74	1.06	<b>0.90</b>
<b>Mean (Storage)</b>	<b>ND</b>	<b>ND</b>	<b>0.56</b>	<b>0.90</b>	
<b>Effects</b>	<b>C.D<sub>(p≤0.05)</sub></b>				
Treatment (T)	0.02				
ND: Not Detected					



**Fig. 3. Effect of treatment and storage intervals on overall acceptability (Hedonic score) of instant *khichdi* mix**

might be attributed to non-enzymatic browning reaction (Maillard reaction) [33]. Semwal et al. [37] also reported that the sensory scores of instant pulav mix decreased during storage of 90 days, Rahangdale et al. [4] in kodo millet fortified *khichdi* during 90 days of storage and Kokani et al. [38] in instant brown rice kheer mix.

#### 4. CONCLUSION

It is evident that the iron, calcium, potassium and phenolic content of instant *khichdi* mix was greatly influenced as the ratio of incorporation increased. For the formulation of nutritious instant *khichdi* mix, instant brown rice and dehulled mungbean can be blended in the ratio of 60:40:: instant brown rice: instant dehulled mungbean. The best composite instant *khichdi* mix i.e. T<sub>5</sub> (60:40::IBR:IDM) exhibited 5.12 mg per 100g iron, 59.56 mg per 100g calcium, 611.87 mg per 100g potassium and 143.43 mg GAE per 100g total phenolic content as compared to control instant *khichdi* mix having values for the same constituents as 3.53 mg per 100g, 26.65 mg per 100g, 256.40 mg per 100 g

and 53.37 mg GAE per 100g, respectively. Sensory evaluation revealed that the highest mean overall acceptability scores of 7.91 was recorded in T<sub>5</sub> (60:40::IBR:IDM) which was adjudged as superior among all the treatments of instant *khichdi* mix. The formulated instant *khichdi* mix retained its quality throughout the storage period of 90 days with total microbial count within safe limits.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Monika. Studies on Development of Instant Rajmash and Rice Convenient Mix. M.Sc. Thesis, Chaudhary Charan Singh Haryana Agricultural University, Hissar, India; 2017.
2. Federici E, Gentilucci V, Bernini V, Vittadini E, Pellegrini N. Ready to eat shelf-stable brown rice in pouches: Effect of moisture content on product's quality and stability.

- European Food Research and Technology. 2021;247(11):2677-2685.
3. Shetti S. Development of little millet khichdi mix incorporated with green gram dal and tomato powder. *Journal of Emerging Technologies and Innovative Research*. 2022;9(4):256-259.
  4. Rahangdale H, Khan MA, Rana GK, Dubey AD. Quality evaluation of kodo millet fortified *khichdi* during storage. *Progressive Research-An International Journal*. 2015;10:2030-2032.
  5. Durgarao MNV. Studies on development of process for preparation of instant khichdi. M.Sc thesis. Vasanttrao Naik Marathwada Krishi Vidyapeeth, Parbhani, India; 2017.
  6. Zhou Z, Robards K, Helliwell S, Blanchard C. Composition and functional properties of rice. *International Journal of Food Science and Technology*. 2002;37:849-868.
  7. Mir SA, Bosco SJD, Shah MA, Mir MM, Sunooj KV. Variety difference in quality characteristics, antioxidant properties and mineral composition of brown rice. *Journal of Food Measurement and Characterization*. 2016;10:177-184.
  8. Babu DP, Subhasree RS, Bhakayaraj R, Vidhyalakshmi R. Brown rice-beyond the color reviving a lost health food- a review. *American-Eurasian Journal of Agronomy*. 2009;2(2):67-72.
  9. Mir SA, Shah MA, Bosco SJD, Sunooj KV, Farooq S. A review on nutritional properties, shelf life, health aspects, and consumption of brown rice in comparison with white rice. *Cereal Chemistry*. 2020;97(5):5-13.
  10. Singh A, Jaiswal M, Agrahari K, Singh A. Standardization and development of moong dal based products. *International Journal of Home Science*. 2017;3(1):358-362.
  11. Paul T, Mozumder NH, Sayed MR, Akhtaruzzaman M. Proximate composition, mineral content and determination of protease activity from green gram (*Vigna radiata* L.). *Bangladesh Research Publications Journal*. 2011;5:207-213.
  12. Gujral HS, Sharma P, Sharma R. Antioxidant properties of sand roasted and steam cooked bengal gram (*Cicer arietinum*). *Food Science and Biotechnology*. 2013;22(1):183-188.
  13. Toan NV, Vinh TQ. Production of nutritional bars with different proportions of oat flour and brown rice flour. *Clinical Journal of Nutrition and Dietetics*, 2018;1(1):1-11.
  14. Ninthiya N, Vasantharuba S, Subajini M, Srivijeindran S. Formulation of instant soup mix powder using uncooked palmyrah (*Borassus flabellifer*) tuber flour and locally available vegetables. In: *Proceedings of Jaffna University International Research Conference*. University of Jaffna, Sri Lanka. 2014;198-202.
  15. Ahmed ZS, Abozed SS. Functional and antioxidant properties of novel snack crackers incorporated with *Hibiscus sabdariffa* by-product. *Journal of Advanced Research*. 2015;6(1):79-87.
  16. AOAC. *Official Methods of Analysis*. 19th edition, Association of Official Analytical Chemists, Washington, D.C; 2012.
  17. Luo AX, He XJ, Zhou SD, Fan YJ, He T, Chun Z. *In vitro* antioxidant activities of a water-soluble polysaccharides derived from *Dendrobium nobile* Lindl. extracts. *International Journal of Biological Macromolecules*. 2009;45(3):359-363.
  18. Palczar MJ, Chan ECS. *Laboratory Exercise in Microbiology*. Black Dot Inc., New York, USA; 1991.
  19. Amerine MA, Pangborn RH, Rossler EB. *Principles of Sensory Evaluation of Food*. Academic Press, New York. 1965;23-45.
  20. Joshi S, Srivastava S. Barnyard millet as a substitute of rice in preparation of *khichdi* for diabetics. *International Journal of Science and Research*. 2016;5(6):1798-1802.
  21. Rana GK, Khan MA, Singh Y. Quality assessment of multigrain dalia formulated from cereals and legume mix. *Indian Research Journal of Genetics and Biotechnology*. 2015;7(4):415-421.
  22. Khandekar SP, Ranveer RC, Sahoo AK. Development of ready to cook vegetable *khichadi* mix by microwave drying technology. *Journal of Postharvest Technology*. 2020;8(4):1-8.
  23. Akhtar S, Anjum FM, Sheikh MA. Effect of storage and baking on mineral contents of fortified whole wheat flour. *Journal of Food Processing and Preservation*. 2010;34(2):335-349.
  24. Rokhsana F, Yeasmin R, Nahar A. Studies on the development and storage stability of legume and vegetable based soup powder. *Bangladesh Journal of Agricultural Research*. 2007;32(3):451-459.
  25. Zeb F, Nasrullah PR, Khan S. Organoleptic evaluation and storage stability attributes

- of various complementary food mixes. Journal of Clinical Nutrition and Dietetics. 2017;3(2):1-8.
26. Murugkar DA, Gulati P, Gupta C. Effect of sprouting on physical properties and functional and nutritional components of multi-nutrient mixes. Journal of Food Science and Technology. 2013;48(3):325-328.
  27. Jan A, Sood M, Bandral JD, Hussain PR, Norzom T, Nazir A, Masoodi L. Sensory and microbiological evaluation of brown rice based weaning food. The Pharma Innovation Journal. 2018;7(3):31-34.
  28. Muzzaffar S, Baba WN, Nazir N, Masoodi FA, Bhat MM, Bazaz R. Effect of storage on microbial and antioxidant properties of pumpkin (*Cucurbita moschata*) candy. Cogent Food and Agriculture. 2016;2(1):1-13.
  29. Slathia S, Bandral JD, Sood M. Quality evaluation of noodles supplemented with germinated mungbean flour. International Journal of Food Fermentation and Technology. 2016;6(2):451-456.
  30. Jyoti S, Inderdeep BK, Hage R, Teshering D, Kurma ST, Prasad R, Sawinder K. Process optimisation for the preparation of ready to cook maize based porridge mix. Think India Journal. 2019;22(12):485-499.
  31. Joshi N, Bains K., Kaur H. Evaluation of antioxidant activity of developed instant soup mixes using vegetable leaf powders from unconventional greens. International Journal of Current Microbiology and Applied Sciences. 2020;9(1):711-721.
  32. Showkat S, Dar AH, Khan S, Gani M. Effect of mungbean and rice on physico-chemical, sensory and microstructural properties of cereal bars. Journal of Food Science and Technology. 2018;10(4): 70-78.
  33. Munasinghe MA, Silva DD, Rasika KFST, Jayarathne DMD, Sarananda KH. Formulation and sensory evaluation of yoghurt-based weaning foods manufactured from mungbean, soybean and brown rice. International Journal of Scientific and Research Publications. 2013;3(4):2250-3153.
  34. Sharma B. *Standardisation and Evaluation of Maize based Convenience Foods*. Ph.D Thesis, Sher-e- Kashmir University of Agricultural Sciences and Technology, Jammu, India; 2013.
  35. Chakroborty T, Chakroborty SC. Effect of storage temperature on the quality and microbial content of salt-smoke-dried shoal (*Ophiocephalus striatus*). Journal of Fisheries and Livestock Production. 2017;05(01):1-4.
  36. Yadav DK, Wadikar DD, Vasudeesh CR, Patki PE. Development and storage stability of RTE Bengal gram (*Cicer arietinum*) based spiced snacks-Chana Nibble. International Food Research Journal. 2016;23(1):77-79.
  37. Semwal AD, Sharma GK, Patki PE, Padmashree A, Arya SS. Studies on development and storage stability of instant vegetable pulav mix. Journal of Food Science and Technology. 2001;38(3):231-234.
  38. Kokani RC, Gade SY, Balsaraf SS. Studies on formulation and quality evaluation of instant brown rice kheer mix. International Journal for Innovative Research in Science and Technology. 2019;6(5):1-4.

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