

## Research Article

# Utilization of potato powder as a rice substitute in instant kheer mix development

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### Citation

Zarina Noor, Asadullah Marri, Nida Shaikh, Asif Irshad, Imtiaz Ghafoor, Alam Khan and Mohammad Shakir. Utilization of potato powder as a rice substitute in instant kheer mix development. Pure and Applied Biology. Vol. 13, Issue 3, pp303-310. <http://dx.doi.org/10.19045/bspab.2024.130027>

Received: 29/11/2023

Revised: 11/01/2024

Accepted: 20/01/2024

Online First: 26/01/2024

### Abstract

Kheer is a popular dessert in different Southeast Asian countries including Pakistan. It is commonly prepared from rice or any other staple cereal, milk, sugar, etc. Nowadays, conventional cooking methods are becoming an ordeal owing to busy life schedules and thus people prefer instant foods or ready-to-cook (RTC) foods to speed up cooking time. The present study aimed to develop an enhanced instant kheer mix by replacing rice with potato powder to enhance its nutritional value and sensory characteristics. Four different treatments were prepared: T<sub>0</sub> (control) without potato powder, T<sub>1</sub> at 75:25, T<sub>2</sub> at 50:50, and T<sub>3</sub> at 25:75 rice flour to potato powder, respectively. The samples were assessed for their physicochemical and sensorial characteristics using standard analytical methods. The results showed statistically significant differences ( $p < 0.05$ ) among all treatments revealing that T<sub>3</sub> has significantly higher average values for protein (4.95%), fat (3.65%), carbohydrate (30.05%), ash (2.45%), fiber (1.09%), color (8.66), taste (9.0), consistency (9.00), aroma (8.33) and overall acceptability (8.66). Carbohydrate and pH values remained significantly higher in T<sub>1</sub> (i.e., 68.12% and 4.36, respectively). T<sub>2</sub> had significantly higher average values for moisture (62.01%). Whereas T<sub>0</sub> showed significantly higher average values for titratable acidity (1.09%) and cooking time (18.47 min). All treatments of instant kheer mix had a good nutritional profile and sensorial acceptance. However, among all treatments, T<sub>3</sub> exhibited an exceptional nutritional profile and degree of likeness. It may be thereby recommended that potato powder-based instant kheer mix should be marketed so that consumers may nutritionally benefit from it.

**Keywords:** Convenience food; Instant kheer mix; Nutritional profiling; Potato powder; Ready-to-cook food; Sensory characteristics; South Asian dessert

### Introduction

Instant products or ready-to-cook (RTC) foods are also called convenience food as they need very little effort for preparation. Instant foods are becoming a need of time since the socio-economic pattern of life is modernizing [1]. The changing lifestyle with women becoming career-oriented has increased the demand for instant foods. The

development of RTC foods for several traditional snack foods offering convenience to the fast food industry and households become a fast-growing trend among processed foods. This concept is very popular in developed countries and is being admired in developing countries as well since is time-efficient [2]. Kheer is a highly popular traditional milk-based sweet

dessert prepared for different social, religious, and festive occasions. It has evolved to suit regional and personal preferences using different cereals and cereal products in which the principal nutrient is starch/carbohydrate [3]. The essential ingredients required for making kheer are milk, sugar, and rice but the recipe of kheer can be varied by replacing rice with vermicelli, semolina, potato powder, and even with shredded fresh carrot (Gajrela), etc. It is garnished with raisins, cashew nuts, pistachios, or almonds and sometimes flavored with cardamom, saffron, and so forth. Whole cereal grains and even beaten cereal products are used for kheer making whereas the consistency of kheer dessert may vary ranging from almost semi-liquid to highly viscous [4].

Potato (*Solanum tuberosum* L.) is one of the major tuber crops in the world. It is a highly valuable tuber produce or crop with a wide range of food-related uses in its fresh state or processed food products. It is an excellent source of carbohydrates, proteins, vitamins (such as ascorbic acid and others), phenolic substances, and minerals (such as P, K, Ca, etc.). The nutritional constituents of potatoes such as starch, non-starch polysaccharides, fibers, sugars, organic, and inorganic compounds, and proteins influence the sensorial quality of potatoes and potato-based food products. Potato powder may be a good functional food ingredient and may be utilized in manufacturing multiple food items such as desserts, bakery products, baby foods, etc [5, 6].

It is direly needed to formulate new innovative instant food recipes to meet consumers' demands and quench their thirst for new food products. Further, according to an estimate, there will be a 9.8 billion population and 50-60% more food demand by 2050 [7]. RTC foods from various traditional dairy products, such as kheer, soup, and cake, are gaining popularity in the fast food industry. These foods offer convenience to processors, chefs, and consumers by reducing preparation time.

However, there is limited research available on RTC or instant kheer mixes. To address this, the present study aimed to develop an instant kheer mix using potato powder as a rice substitute. The traditional methods of kheer preparation involve time-consuming steps like soaking rice, constant stirring and manual homogenizing, etc. This instant kheer mix was developed to overcome these challenges and to evaluate its physicochemical and sensorial attributes.

## **Materials and Methods**

### **Sample collection**

Fresh and wholesome potatoes of Kuroda variety, good grade broken rice kernels, table sugar, almond, pistachio, cashew nut, small cardamom, coconut powder, kheer essence (locally termed as Khewra), milk powder (Nido milk powder, Nestle), saffron stamens were procured from the National Super Mart of Hyderabad city, Pakistan.

### **Preparation of rice flour**

Broken rice kernels were manually cleaned to remove damaged, mold-infected rice kernels, small pebbles, insects, or any unwanted plant materials. The rice kernels were properly washed and dried in a thermal dehydrator at 45°C for 5 hours. The dried rice kernels were milled in to obtain rice flour. After milling the rice flour was packed, labeled, and kept under controlled conditions till further use.

### **Preparation of potato flour**

The potatoes were washed to remove dust or debris from the potato surface and manually peeled using stainless steel peeler. The peeled potatoes were sliced (0.4 cm thickness) and blanched at 70°C for 2 to 3 minutes in 0.5% brine solution to deactivate enzymes that can cause discoloration, preserve color, and improve the overall quality of the potato powder. The slices were strained and dried in perforated trays of dehydrator for 16 hours at 55°C. The dried slices were grinded to obtain potato powder. Potato powders were packed, labeled, and kept under controlled conditions till further use.

## Development of potato powder-based instant kheer mix

The instant kheer mix was developed by the method described by [8] with minor modifications. All required materials were cleaned (nuts, small cardamom, etc.) and used for the kheer mix preparation. Based

on trials conducted for recipe optimization, final recipe formulations were selected. The formulation for each treatment is mentioned in (Table 1). The proportion for all other ingredients which are kept intact in all treatments is shown in (Table 2).

**Table 1. Information regarding different treatments of instant kheer mix**

T <sub>0</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
Control (kheer mix without potato powder)	Rice flour: potato powder (75: 25)	Rice flour: potato powder (50: 50)	Rice flour: potato powder (25: 75)

**Table 2. Information regarding recipe formulation of different instant kheer mix treatments**

Ingredients (g)	T <sub>0</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
Rice flour	100	75	50	25
Potato powder	-	25	50	75
White Table Sugar	30	30	30	30
Milk powder	100	100	100	100
Small cardamom	02	02	02	02
Coconut powder	05	05	05	05
Almonds	10	10	10	10
Pistachios	10	10	10	10
Cashew nuts	10	10	10	10
Kheer essence (drops)	3	3	3	3
Saffron stamens (no.)	2	2	2	2

## Preparation of kheer dessert from instant kheer mix

Kheer dessert samples were prepared by adding 100 g of kheer mix in 250 ml of water. The water was boiled, and 100 g of kheer mix was slowly added. The content was continuously cooked and stirred until the desired consistency of kheer was obtained. After cooking the dessert samples were cooled at room temperature and chilled before sensory evaluation under refrigeration conditions.

## Sample analysis of instant kheer mix dessert

### Physicochemical analysis

Moisture, protein, and ash percentages of instant kheer mix desserts were examined according to the methods of [9]. By following the standard methods of [10], fat content (%), and pH value were determined. Carbohydrate (%) and titratable acidity (%) were analyzed by

the proposed methods of [11], while fiber (%) was evaluated as per the method presented by [12]. For determining the cooking time (min) of the instant kheer mix sample the method described by [13] was followed with minor modifications.

### Sensorial attributes

The sensorial attributes of kheer samples i.e., color, aroma, taste, consistency, and overall acceptability were determined by a panel of twenty judges (including professors and senior students of IFST) as per methods described by [14]. The nine-point hedonic scale was used to determine the sensorial profile of the samples. The 9-point Hedonic scale has scores points from 1 to 9. The score reveals the desirability of the food products as per the judgment of panelists (Like Extremely, Like Very Much, Like

Moderately, Like Slightly, Neither Like nor Dislike, Dislike Slightly, Dislike Moderately, Dislike Very Much, Dislike Extremely i.e., from 9 to backward till 1, respectively).

### Statistical analysis

The data obtained from the present study were analyzed according to the method described by [15]. Three replications were analyzed for all tests on different days in a similar manner. The recovered data were tabulated on Excel sheets and statistically analyzed

using Statistical Package for the Social Sciences (SPSS IBM 20) for ANOVA at  $p$ -value  $< 0.05$ .

### Results and Discussion

#### Physicochemical composition of instant kheer mix

The results regarding the physicochemical composition of different potato powder-based instant kheer mix dessert treatments are presented in (Table 3). The one-way ANOVA showed that all treatments were statistically different ( $p \leq 0.05$ ) from one another.

**Table 3. Physicochemical characteristics of different potato powder-based instant kheer mix dessert treatments**

Treatments	Moisture (%)	Fat (%)	Protein (%)	Carbohydrates (%)	Ash (%)	Fiber (%)	Titrateable acidity (%)	pH value	Cooking time (min)
T <sub>0</sub>	62.01±0.10a	2.38±0.08d	3.58±0.29d	23.18±0.15d	1.08±0.35d	2.05±0.24a	1.09±0.15a	6.4±0.24d	18.47±0.13a
T <sub>1</sub>	60.23±0.18b	2.79±0.10c	3.91±0.11c	26.21±0.10c	1.51±0.43c	1.63±0.12b	1.04±0.11b	6.7±0.12c	16.33±0.15b
T <sub>2</sub>	57.89±0.16c	3.19±0.10b	4.13±0.20b	28.23±0.18b	2.23±0.28b	1.33±0.21c	1.00±0.13c	7.0±0.21b	15.42±0.20c
T <sub>3</sub>	56.65±0.28d	3.65±0.09a	4.95±0.12a	30.05±0.14a	2.45±0.89a	1.09±0.64d	0.08±0.21d	7.3±0.64a	14.21±0.23d
LSD (0.05)	0.311	0.244	0.031	0.067	0.0521	0.0354	0.0211	0.0354	0.0219

\*T<sub>0</sub>= Control (kheer mix without potato powder); T<sub>1</sub>= rice flour: potato powder (75:25); T<sub>2</sub>= rice flour: potato powder (50:50) T<sub>3</sub>= rice flour: potato powder (25:75); LSD= least significant difference

#### Moisture (%)

The moisture content in different kheer mix dessert treatments ranged between 56.25 to 62.33%. Among all treatments, T<sub>0</sub> showed to have a significantly higher mean moisture content (62.01%) followed by T<sub>1</sub> (60.23%) and T<sub>2</sub> (57.89%). However, T<sub>3</sub> showed to have a significantly lower mean moisture content (56.65%). Since water is the main constituent of the kheer dessert and its proportion is higher in comparison to any other constituent, therefore, moisture was found to be a chief constituent of the kheer dessert in the present findings. As usual, consumers prefer kheer dessert with dense consistency rather than less dense owing to avail pleasant mouthfeel. In the present findings, the control sample (T<sub>0</sub>) showed to have higher moisture content in comparison to those with potato powder. This happened might be due to the water-holding capacity of the starch granules in the kheer mix samples. In a similar study, [16] observed a decrease in moisture content by the incorporation of paneer into the carrot-supplemented paneer kheer.

#### Fat (%)

The mean values for fat content varied significantly and ranged between 3.45 to 4.07%. Among all treatments, T<sub>3</sub> showed to have a significantly higher mean fat content (3.65%) followed by T<sub>2</sub> (3.19%) and T<sub>1</sub> (2.79%). However, T<sub>0</sub> was shown to have a significantly lower mean fat content (2.38%). Fat is an important macromolecule that generates substantial energy when oxidized or metabolized in the human body. The fat percent in dairy products has a crucial effect on flavor scores [3]. Milk, available in both liquid and powdered forms, offers a valuable source of fat, with liquid ranging from 3 to 6% and powdered reaching 20 to 40%. According to [17], fat in powdered milk may range from 26.19 to 27.89 g/100 g. In the present study, among all treatments, T<sub>3</sub> showed to have a significantly higher mean fat content (3.65%), and this would be happened due to the interactive effects of the ingredients used for making instant kheer mix. In a study by [18] approx. of

10.94% fat was recorded by the addition of soy and buffalo milk blend to the kheer mix.

#### **Protein (%)**

The average values belonging to protein content ranged from 4.49 to 5.17%. Among all treatments, T<sub>3</sub> showed to have a significantly higher mean protein content (4.95%) followed by T<sub>2</sub> (4.13%) and T<sub>1</sub> (3.91%). However, T<sub>0</sub> showed to have a significantly lower mean protein content (3.58%). Proteins are an important component of the human diet and are tremendous sources of free amino acids in foods. They bring Maillard's reaction when encountering the reducing sugars in the presence of heat which increases the palatability of any food products due to having some amadori products [19]. The current study revealed that T<sub>3</sub> showed to have a significantly higher mean protein content (4.95%) and it is obvious that kheer should have such content of protein owing to having milk powder in it. In a study by [20], the protein remained at 10.52g per 100 grams of cowpea-based instant kheer mix. The recipe of kheer mix showed to have higher protein content (i.e., 4.49 to 5.17%) which is good for consumers especially growing children for their better mental and physical health.

#### **Carbohydrates (%)**

In the present findings, carbohydrate content in different kheer mix dessert treatments ranged between 22.68 to 33.12%. Among all treatments, T<sub>3</sub> showed to have a significantly higher mean carbohydrate content (30.05%) followed by T<sub>2</sub> (28.23%) and T<sub>1</sub> (26.21%). However, T<sub>0</sub> showed to have a significantly lower mean carbohydrate content (23.18%). According to [21], the carbohydrates in rice are their main compositional components and are mainly occurring in the form of starch in the case of rice kernels specifically. On the other side, potato powder is again an immense source of carbohydrates as starch. Therefore, the content of carbohydrates was higher in the T<sub>3</sub> in the potato-based kheer mix formulation. The sugar in the formulation also contributes to increasing

the proportion of carbohydrates in the kheer desserts.

#### **Ash (%)**

The average ash (%) ranged from 1.05 to 2.42% in instant kheer mix dessert samples. Among all treatments, T<sub>3</sub> showed to have a significantly higher mean ash content (2.45%) followed by T<sub>2</sub> (2.23%) and T<sub>1</sub> (1.51%). However, T<sub>0</sub> was shown to have a significantly lower mean ash content (1.08%). The total inorganic constituents that remained after high-temperature ignition are indicative of the overall mineral content in a food product. Ash is indicative of the total mineral content of the commodity. It is obtained by the ignition of all organic matter in the elevated temperature ranging from 550 to 600°C in a furnace leaving behind the inorganic constituents. Kheer dessert is a good source of mineral components (i.e., calcium, phosphorus, etc.). [22] performed a similar study in which they optimized kheer ingredients and their processing time for developing a functional dairy dessert (Kheer). They determined the closely resembling observations for ash content in their study samples as determined in the present study.

#### **Fiber (%)**

The average values belonging to fiber (%) ranged between 1.87 to 2.24%. Among all treatments, T<sub>3</sub> showed to have a significantly higher mean fiber content (2.05%) followed by T<sub>2</sub> (1.63%) and T<sub>1</sub> (1.33%). However, T<sub>0</sub> showed to have a significantly lower mean fiber content (1.09%). Dietary fibers are valuable health-promoting compounds. They act as prebiotics and are anti-constipation agents since facilitate laxative or defecating impact on the excretory system of the human being. [23] stated that the fibers in rice are good against their hypoglycemic properties. In another study, [24] suggest that potatoes are rich in fiber which is responsible for promoting a healthy gut microbiota. In this study, the fiber content remained satisfactory while fiber was



mainly seen in T<sub>3</sub> rather than in other counterpart treatments.

#### **Titrateable acidity (%)**

The average titrateable acidity (%) ranged from 0.09 to 1.13%. Among all treatments, T<sub>0</sub> showed to have significantly higher mean titrateable acidity (1.09%) followed by T<sub>2</sub> (1.04%) and T<sub>1</sub> (1.00%). However, T<sub>3</sub> showed to have a significantly lower mean titrateable acidity (0.08%). Titrateable acidity may also be defined as the total acidity of any food commodity. It measures the total acid (organic acids mainly) concentration in a food product. Mainly, this attribute of food products is determined by the exhaustive titration of the content of intrinsic acids using a standard alkali. This is a suitable predictor of acid's impact on the pH of the food product. Since kheer is a milk-based commodity therefore its titrateable acidity is usually lower in ranges. In the present study, however, it remained higher in T<sub>0</sub>/control treatment rather than in kheer mixes with potato powder. In a similar study, [16] observed a decrease in titrateable acidity with the addition of carrot paste and paneer to the kheer mix.

#### **pH value**

The pH value in different kheer mix treatments ranged between 6.1 to 7.5. Among all treatments, T<sub>3</sub> showed to have a significantly higher mean pH value (7.3) followed by T<sub>2</sub> (7.0) and T<sub>1</sub> (6.7). However, T<sub>0</sub> was shown to have a significantly higher mean pH value (6.4). The determination of pH value in food commodities reveals many food attributes such as it is indicative of acidity or alkalinity of the food products, while it is also associated with the shelf-life of the food commodity. The acidic pH lowers microbial contamination and thus increases the shelf life of the food commodity. [17] reveal that the pH of different brands of milk may vary. However, milk is a slightly basis food. In the present findings, the pH value was found higher in the control treatment which correlates with the findings of [25] who observed a decrease in pH value with the

addition of sweet potato paste to the kheer mix.

#### **Cooking time (min)**

The cooking time ranged between 14.56 to 18.54 min in different kheer mix treatments. Among all treatments, T<sub>0</sub> showed to have a significantly higher mean cooking time (18.47 min) followed by T<sub>1</sub> (16.33 min) and T<sub>2</sub> (15.42 min). However, T<sub>3</sub> showed to have a significantly lower mean cooking time (14.21 min). Kheer mixes are RTC food products that require minimal processing operations to prepare food commodities and thus a minimal time of preparation as well. In the present study, among all treatments, T<sub>0</sub> showed to have a significantly higher mean cooking time (18.47 min). As usual, the traditional method of preparing/cooking kheer dessert is time-consuming and laborious as well. However, instant kheer mixes prepared in the present study were cooked in very minimal time.

#### **Sensorial analysis of instant kheer mix dessert**

The organoleptic characteristics are tools to assist the desirability and eating quality of any newly developed food product. The degree of food product acceptance can be effectively judged by the consumers. The results regarding mean scores for organoleptic analysis of different potato powder-based instant kheer mix treatments are presented in (Table 4). The one-way ANOVA showed that all treatments were statistically different ( $p \leq 0.05$ ) from one another.

The score of color, aroma, taste, consistency, and overall acceptability were significantly ( $p \leq 0.05$ ) higher in T<sub>3</sub> i.e., 8.66, 8.33, 9.00, 9.00, and 8.66, respectively, followed by T<sub>1</sub> i.e., 8.00, 8.00, 8.33, 8.33 and 8.33 and T<sub>2</sub> i.e., 7.33, 7.66, 7.66, 7.66 and 7.66 respectively, while a lower score of color, aroma, taste, consistency, and overall acceptability was observed in T<sub>0</sub> i.e., 7.00, 7.33, 7.00, 7.33 and 7.33 respectively.

In the present study, the sensorial scores for all attributes were better perceived by the T<sub>3</sub>

which indicates the degree of preference by the panel of judges. It might be happened due to the adding potato powder as a variant

in the instant kheer mixes while general market-based instant kheer mixes are made from rice flour.

**Table 4. Sensorial characteristics of different potato powder-based instant kheer mix dessert treatments**

Treatments	Color	Aroma	Taste	Consistency	Overall acceptability
T <sub>0</sub>	7.00 ± 0.34 d	7.33 ± 0.33 d	7.00 ± 0.32 d	7.33 ± 0.28 d	7.33 ± 0.31 d
T <sub>1</sub>	7.33 ± 0.14 c	7.66 ± 0.13 c	7.66 ± 0.12 c	7.66 ± 0.13 c	7.66 ± 0.13 c
T <sub>2</sub>	8.00 ± 0.15 b	8.00 ± 0.14 b	8.33 ± 0.11 b	8.33 ± 0.16 b	8.33 ± 0.12 b
T <sub>3</sub>	8.66 ± 0.37 a	8.33 ± 0.33 a	9.00 ± 0.31 a	9.00 ± 0.29 a	8.66 ± 0.32 a
LSD (0.05)	0.0166	0.0175	0.0163	0.0166	0.0123

\*T<sub>0</sub>= Control (kheer mix without potato powder); T<sub>1</sub>= rice flour: potato powder (75:25); T<sub>2</sub>= rice flour: potato powder (50:50) T<sub>3</sub>= rice flour: potato powder (25:75); LSD= least significant difference

### Conclusion and Recommendations

The present study concludes that all treatments of instant kheer mix dessert (T<sub>0</sub>-T<sub>3</sub>) were recorded to have good nutritional and sensorial attributes. However, among potato powder-based instant kheer mix treatments, T<sub>3</sub> (with a higher ratio of potato powder) exhibited a comparatively superior nutritional profile i.e., higher protein content, ash content, fat content, carbohydrate content, and degree of likeness. Potato powder has a high nutritional value, being a good source of carbohydrates, protein, fiber, and vitamins. It also has a neutral flavor, which makes it a suitable ingredient for kheer. Substituting potato powder for rice in kheer dessert also offers potential economic benefits through cost saving, as potato powder is often more affordable than rice flour, thereby enhancing the overall cost-effectiveness of the dessert preparation. It may be thereby recommended that potato powder-based instant kheer mix should be marketed to provide consumers with a nutritious and enjoyable dessert option.

### Authors' contributions

Conceived and designed the experiments: Z Noor & A Marri, Performed the experiments: Z Noor, N Shaikh & A Irshad, Analyzed the data: A Marri & N Shaikh, Contributed materials/ analysis/ tools: A Ghafoor, A Khan & M Shakir, Wrote the paper: A Irshad.

### Acknowledgments

The authors gratefully acknowledge the Institute of Food Sciences and Technology, Sindh Agriculture University, Tando Jam, Pakistan for the provision of the required facilities to conduct the research.

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