Indigenous knowledge, optimum recipe and storage stability of *khurma*, a cereal based traditional Nepalese product.

Nirat Katuwal (niratkatuwal@gmail.com)
Food Technology and Quality Control Office https://orcid.org/0000-0001-9504-4134

Aashika Subedi
Tribhuvan University Central Department of Food Technology, Dharan, Nepal

Sujan Sapkota
Food Management and Trading Company Limited, Kathmandu, Nepal

Yadav KC
Central Campus of Technology, Tribhuvan University, Dharan

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Abstract

Khurma is a cereal based food indigenous to hilly regions of Nepal. It is a deep fried flour confection prepared by mixing wheat flour, rice flour, semolina, *ghee*, sugar, spices mixture, milk and water. Despite its popularity, the scientific documentation and researches in *khurma* is scarce. Moreover, quality of *khurma* is often subject to variation due to differences in recipe and the data on storage stability is unavailable. Therefore, in this study recipe of the product was optimized using sensory analysis and the optimized product was analysed for physicochemical parameters and storage stability. Proximate analysis showed that optimized *khurma* had 2.48 ± 0.12%, 36.87 ± 0.34%, 9.51 ± 0.47%, 0.48 ± 0.03%, 0.06 ± 0.01% and 50.60 ± 0.82% of moisture, fat, protein, total ash, crude fiber and carbohydrates respectively. Moreover, product was more stable in laminated packaging material compared to polyethene (PE) package. The results showed that *khurma* can be served and promoted as an energy dense snack.

1. Introduction

Traditional foods produced throughout the world by different communities. They are important components in the dietary pattern even in the developed societies [1] and are considered as an expression of history, culture and lifestyle [2].

Nepal is rich in ethnical and cultural diversity. Several varieties of traditional foods are available in the country. The knowledge of preparation is inherited from the ancestors and transferred from one generation to other through teaching and preparing at home. Quality of such products are maintained using sense for example by looking, smelling, touching, tasting and improved over generation through slight modifications in the procedures [3,4].

Khurma is a deep fried flour confection consumed mainly in hilly region of western Nepal (Fig. 1). It is reddish brown in colour and has closed palm or fist like shape. The major ingredients for its preparation include wheat flour, rice flour, semolina, spices, *ghee*, sugar, milk and water. It is often prepared in major festivals and taken as a gift for the bridegroom's home in marriage ceremonies. *Khurma* preparation is common mainly in the ethnic communities like *Brahmin*, *Chhetri* and *Newar.* These communities are considered rich in tradition and cultures, and most of them are involved in agriculture and trade.

For traditional food to sustain in this modern era, it needs to meet the criteria of quality, nutrition, convenience etc. Further, appropriate packaging which could extend shelf life of these products is much important for proper distribution [5]. These are necessary for promotion and sustainability of traditional foods. However, recipe, technology, cultural aspects, composition, storage stability etc. of *khurma* has not been documented and quality of *khurma* is often subjected to variation depending on availability of raw material, processing steps, locality and convenience. Thus, this work aims to report indigenous knowledge, optimize the recipe and report storage stability of *khurma*.

2. Materials And Methods

2.1 Materials

2.1.1 Raw materials

All raw materials required for the preparation of *Khurma* (refined wheat flour, rice flour, sunflower oil, *ghee*, semolina, sugar and spices) were procured from the local market.

2.1.2 Cooking utensils

A rectangular wooden dye having length 30 cm and breadth 13 cm was chosen to shape the *khurma*. The wooden roller was used to flatten the lump of dough. For frying stainless steel frying pan (locally called *karai*) was used.

2.1.3 Chemicals

Unless specified elsewhere, chemicals used in this study were purchased from Qualigen Fine Chemicals, India.

2.2 Methods

2.2.1 Survey

A survey, based on semi structured questionnaires was carried out to understand the indigenous knowledge of *khurma* such as cultural importance, formulation, preparation method, process variables and storage stability. A total of 25 people agreed and participated in the survey. They belonged to the ethnic group involved in *khurma* preparation from ancient times and were from the hilly communities of western Nepal (Fig. 1).

2.2.2 Preparation of *khurma*

Ghee was whipped properly and sugar was added to it. Whipping was continued until optimum consistency was achieved and flour mixture (wheat flour and either rice flour or mixture of rice flour and semolina) and powdered spices (equal proportion of clove and small cardamom) were added in it. It was mixed for about 4-5 min and kneaded to prepare dough by adding water or milk or their mixture. Then small portion of the dough (10 g) was taken and moulded in a rectangular shaped wooden dye and fried in refined sunflower oil. The oil with acid value (AV) less than 0.20 and peroxide value (PV) less than 4.0 m. eq. peroxide oxygen/kg was accepted and used for frying purpose. After frying product was allowed to cool to room temperature and stored appropriately (Fig. 2).

2.2.3 Recipe optimization

The ratio of rice flour and semolina, amount of sugar and *ghee* and the ratio of water and milk was varied depending on respondent but amount or proportion of other ingredients were fairly constant. So, in this study, these ingredients were optimized sequentially.

2.2.3.1 Ratio of rice flour to semolina

To optimize ratio of rice flour and semolina, six different types of *khurma* samples were prepared by varying their ratio as 100:0, 80:20, 60:40, 40:60, 20:80 and 100:0 keeping level of other ingredients constant. The ratio with highest sensory acceptability was taken as optimum.

2.2.3.2 Amount of *ghee*

Different types of *khurma* samples were prepared by varying the amount of *ghee* as 6, 9, 12 and 15% in the overall mixture and keeping proportion of other ingredient constant. Optimum level was estimated by selecting the level of *ghee* which resulted in *khurma* with highest sensory acceptability.

2.2.3.3 Amount of sugar

Four types of *khurma* samples differing in amount of sugar (6, 9, 12 and 15%) but with constant proportion of other ingredients were prepared and subjected to sensory analysis. The amount of sugar used which resulted in highest sensory acceptability was taken as optimum.

2.2.3.4 Ratio of water and milk

Six types of different *khurma* samples were prepared by varying the ratio of water to milk as 100:0, 80:20, 60:40, 40:60, 20:80 and 100:0 and keeping proportions of other ingredients constant. The ratio which resulted in highest sensory acceptability was taken as optimum.

2.2.4 Study of storage stability

For evaluation of storage stability, *khurma* prepared with optimized recipe were stored in three different conditions viz., open condition (without packaging), packed in polyethene (PE) pouch (35 μm) and laminated pouch (PE 12μm + MET BOPP 20μm). These products were stored for 50 days and analysed for acid value (AV) and peroxide value (PV) at the interval of 10 days viz., 0, 10, 20, 30, 40 and 50 days. According to regulatory standard of Government of Nepal the maximum permissible limit for acid value and peroxide value of extracted fat for deep fried product such as noodles is 1 mg KOH/g and 10 m. eq. peroxide oxygen/kg [6] . These criteria were taken for judging the loss of storage life of *khurma*.

2.2.5 Proximate analysis

Moisture (hot air oven method), fat (solvent extract in soxhlet), protein (kjeldahl method), crude fiber, total ash and acid insoluble ash were determined by the method described previously [7]. Carbohydrate content was determined by subtracting moisture, fat, protein, crude fiber and ash contents from 100.

2.2.6 Determination of acid value (AV) of extracted fat

Khurma sample was powdered and its fat was extracted with petroleum ether. After evaporation of solvent, AV was determined by the method described previously [8].

2.2.7. Determination of peroxide value (PV) of extracted fat

Khurma sample was powdered and its fat was extracted with hexane. After evaporation of solvent, PV was determined by the method described previously [8].

2.2.8 Energy value

The energy value of the sample was determined by multiplying the physiological energy value for carbohydrate (4 kcal/g), protein (4 kcal/g) and fat (9 kcal/g) [9].

2.2.9 Sensory analysis

Sensory analysis was carried out using 9-point hedonic rating test [10]. Ten semi-trained panelists consisting of food technologist who consumed *khurma* frequently in different occasions were selected and asked to rate the sample for overall sensory acceptability.

2.2.10 Data analysis

All analytical measurements were made in triplicates. Sensory data were analysed using non-parametric Friedman test with Dunn-Bonferroni post hoc test for multiple comparison (at p=0.05). Data of storage stability were analysed using two-way analysis of variance (ANOVA) and Tukey's honestly significant difference (HSD) post hoc test for multiple comparison (at p=0.05). Friedman test and analysis ANOVA were performed in SPSS version 20 (IBM Corporation, Marlborough, MA, USA) and all other calculations and graph plotting were performed in Microsoft Office Excel 2016 (Microsoft Corporations, USA).

3. Results And Discussion

3.1 Indigenous knowledge of *khurma*

Twenty-five different individuals involved in regular *khurma* preparation were involved in the survey. Among them 96% were female and rest (4%) were male. Age of respondents was between 25-50 years. Among racial groups the highest numbers of respondents were *brahmin* followed by *newars* and *chhetri.*

3.1.1 Ethnic community involved and cultural importance

Khurma preparation and consumption was found to be popular among *Bhramhin*, *chhetri* and *newar* communities belonging to the western hilly region of Nepal. It is also called *mudkyaula* by some peoples due to its closed palm or fist (*muththi*, in nepali) shape. It is prepared and served mostly in festivals like *Tihar (Depawali), Makar Sankranti* and other ritual occasions. *Khurma is* also taken to bridegroom's home as a gift (*koseli/sagun*) from their in-laws during marriages.

3.1.2 Ingredients and methods of preparation

The ingredients for the preparation of *khurma* are wheat flour, rice flour, semolina, sugar, cow *ghee*, spices powder (clove and small cardamom), milk, water and refined sunflower oil. The variety of wheat and rice is not specific. However, there were some variations in the use of these ingredients depending on the respondents.

For preparation of *khurma, ghee* is whipped and equal amount of sugar is added to it. Then whipping is continued until required doneness and flour mixture (50 % wheat flour and 50 % either rice flour or mixture of rice flour and semolina) is added to it. Mixing is continued for another 4 -5 min and the mixture is kneaded into dough by adding either water, milk or their mixture. From the dough prepared in this way, about 10 g is taken and moulded in a flattened wooden dye with wooden roller (Fig. 3) into appropriate shape and then deep fried in refined sunflower oil with mild heating until reddish brown colour appears which takes about 7 min to complete. Finally, the product is cooled to room temperature and packed.

3.1.3 Storage stability of *khurma*

Most of the respondents packed it in air-tight glass or plastic containers. From preliminary survey it was found that 25% people believed that it has shelf life less than 1 month, 45% people believed that it has shelf life about one month and remaining 30% people claimed that it has shelf life more than one month packaging in air tight container. Main defects on storage was hardening of texture and brittleness.

3.2 Recipe optimization

Variation in the ratio of rice flour and semolina, ratio of water and milk, amount of *ghee* and amount of sugar significantly affected overall sensory acceptability of *khurma* ($p<0.05$) (Fig. 4). The rice flour to semolina ratio of 40:10 had significantly high sensory acceptability compared to other proportions. Addition of milk did not affect sensory acceptability until water to milk ratio of 60:40 but increased significantly at water to milk ratio of 40:60 and remained unchanged on further increasing the proportion of milk. Moreover, increase in sugar content to 12% significantly increased sensory acceptability but decreased on further increasing the amount. On the other hand, increasing the amount of *ghee* beyond 6% decreased overall sensory acceptability. The optimized recipe of *khurma* from sensory analysis is given in Table 1.

3.3 Proximate composition of *khurma*

Khurma prepared from optimized recipe was high in carbohydrates and fat contents, moderate in protein and minerals, and low in fiber content (Table 2). The low moisture content confers crisp texture and as the high moisture favours microbial growth the product may be relatively stable against microbial spoilage [11–13]. The fat in *khurma* is mainly contributed by *ghee* and sunflower oil. *Ghee* (also known as clarified butter) has been utilized as a therapeutic agent in Ayurvedic system of medicine. Though some studies suggested unhealthy effects of *ghee* consumption due to its saturated fatty acid contents, several other studies have reported its beneficial effects, including decrease in serum total cholesterol, low density lipoproteins and triglycerides; decreased liver total cholesterol, triglycerides, and cholesterol

esters [14,15]. Also, lower prevalence of coronary heart diseases has been reported in men who consumed higher amount of ghee [14]. Further, sunflower oil is rich in health promoting oleic and stearic acids [16]. Protein, ash and fiber are contributed by wheat flour, semolina and rice.

Moisture, carbohydrates, crude fiber content is lower whereas fat, protein, ash content of *khurma* is higher compared to those reported for *selroti* (a cereal based traditional product) [17]. The product has moisture content comparable to some sweet plain biscuits varieties, ash content comparable to some sweet filled biscuits varieties, and protein content comparable to some varieties of snack biscuits, sweet biscuits and crackers whereas it has higher fat content compared to these industrialized biscuits [18]. Moreover, comparable fat content and energy values have been reported in wheat based biscuits improved beniseed and unripe plantain [19]. This implies that, proximate composition of *khurma* is comparable to industrialized product thus it has commercial potential.

3.4 Storage stability of *khurma*

3.4.1 Acid value of extracted fat

Types of packaging and time of storage significantly affected acid value (AV) of extracted fat ($p<0.05$). Laminated pack (12 μm PE and 20 μm Met BOPP) was more effective for stability of product in terms of acid value compared to PE (35 μm) pouch. The AV of extracted fat increased from 0.51 mg KOH/g at the beginning of storage to 1.73, 0.97 and 0.90 mg KOH/g at 50 days of storage in products kept without packaging, in PE pouch and in laminated pouch respectively (Fig. 5). If the maximum permissible limit of AV of extracted fat for deep fat fried product such as noodles i.e. 1 mg KOH/g is considered for *khurma* [6], it can be stored for slightly more than 30 days without packaging and can be stored safely up to 50 days in PE and laminated pouches.

3.4.2 Peroxide value of extracted fat

Type of packaging and storage days significantly affected peroxide value (PV) of extracted fat of *khurma* ($p<0.05$). In terms of PV, the products kept in laminated pouch (12 μm PE and 20 μm Met BOPP) had more stability compared to those packed in PE (35 μm) and kept without packaging. The value of PV of extracted fat increased from 3.96 m. eq. peroxide oxygen/kg at the beginning to 25.49, 20.56 and 17.05 m. eq. peroxide oxygen/kg at 50 days of storage in product kept without packaging, in PE pouch and in laminated pouch respectively (Fig. 6). If the maximum permissible limit of PV of extracted fat in deep fat fried product such as noodles i.e. 10 m. eq. peroxide oxygen/kg is considered for *khurma* [6], it can be kept for less than 10 days without packaging, slightly more than 10 days in PE pouches and slightly more than 20 days in laminated pouches. However, the product had not developed rancid flavor when it reached the peroxide value of 10 m. eq. peroxide oxygen/kg. Thus, further researches are needed to determine maximum acid value and peroxide value for storage stabilities.

Increase in free fatty acids and peroxides causes product to become rancid and unacceptable. Light, oxygen, pro-oxidants, hydrolytic enzymes increases the rate of lipid degradation [20–22]. This might be

the reason behind lower shelf life of *khurma* kept without packaging. Moreover, laminated packaging have more barrier properties viz., low gas transmission rate (GTR) and water vapour transmission rate (WVTR), so laminated packaging materials are expected to provide longer shelf life [23]. Increase in free fatty acids and peroxide values in food products with storage days have been reported [24–27].

Conclusion

In summary, *khurma* prepared with optimized recipe was high in carbohydrates, fat, and energy, moderate in protein and minerals, and low in fiber contents. The product is more stable in laminated package with more than 20 days of storage life when compared to regulatory standards of deep fat fried product (noodles) for acid values (AV) and peroxide values (PV). However, further researches are required to determine quality standards for *khurma* and its shelf life at different conditions of packaging.

Abbreviations

ANOVA: analysis of variance

AV: acid value

BOPP: biaxially oriented polypropylene

GTR: gas transmission rate

HSD: honestly significant difference

PE: polyethene

PV: peroxide value

SPSS: statistical package for social science

WVTR: water vapour transmission rate

Declarations

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Competing interest: authors declare no competing interest.

Availability of data and material: the data are available from the corresponding author, [N K], upon reasonable request.

Author's contribution: NK conceived, supervised the work and wrote the MS; AS carried out the work, SS supported to write the MS, YKC helped in editing the MS.

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Tables

Table 1 Optimized recipe of *khurma*

S.N.	Ingredients	Percentage by weight
1	Wheat flour	27.2
2	Rice flour and Semolina (in the ratio 40:10)	27.2
3	Spices mix	0.4
4	*Ghee*	6
5	Sugar	12
6	Mixture of water and milk (in the ratio 40:60)	27.2

Table 2 Proximate composition of *khurma*

Parameters	Values
Moisture content (%)	2.48 ± 0.12
Fat (%)	36.87 ± 0.34
Protein (%)	9.51 ± 0.47
Ash (%)	0.48 ± 0.03
Carbohydrate (%)	50.60 ± 0.82
Acid insoluble ash (%)	0.04 ± 0.02
Crude fiber (%)	0.06 ± 0.01
Energy (kcal/100g)	572.27 kcal

*values are means ± standard deviation.

Figures

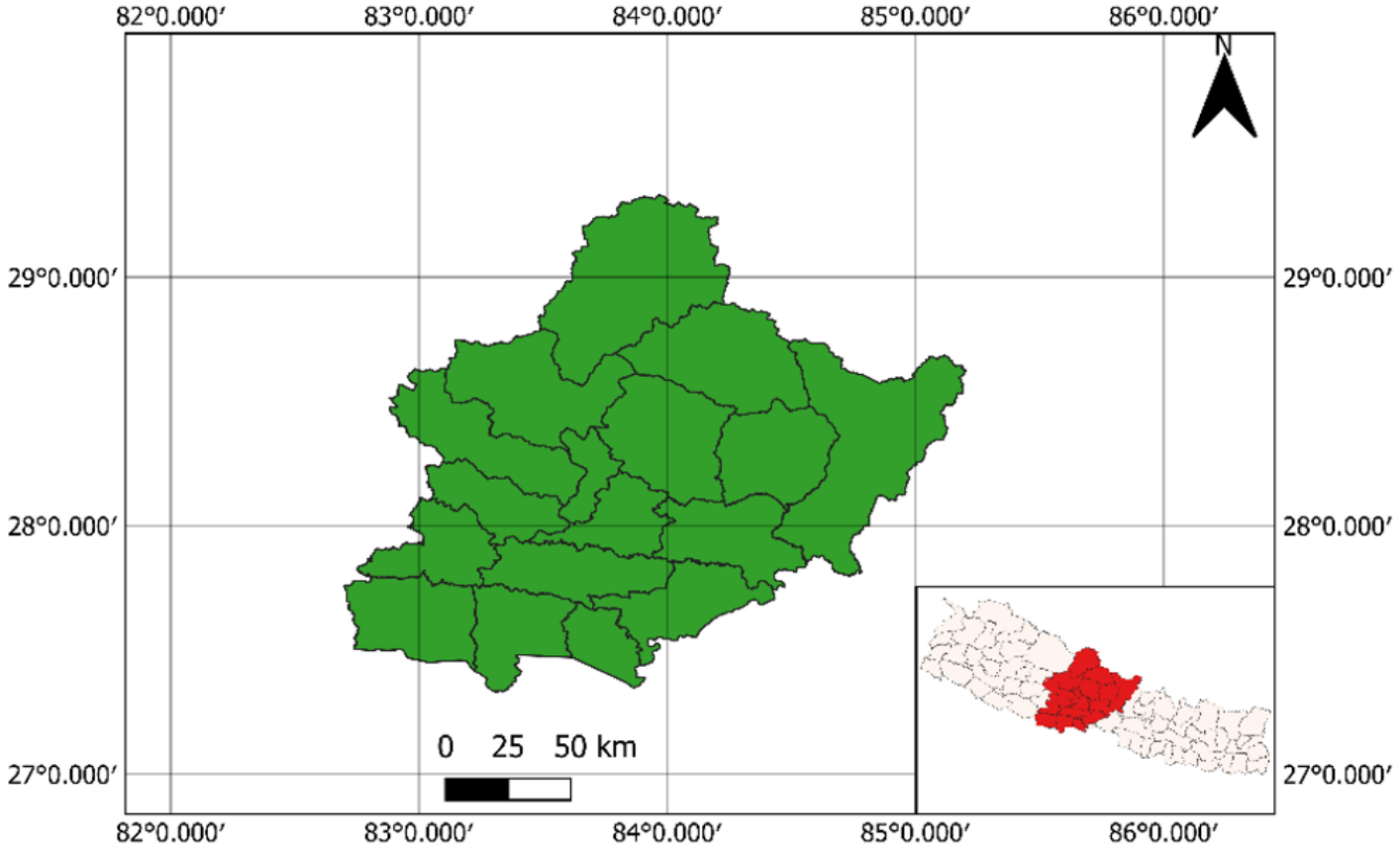

Figure 1

Western Development Region of Nepal (Lumbini Province and Gandaki Province). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

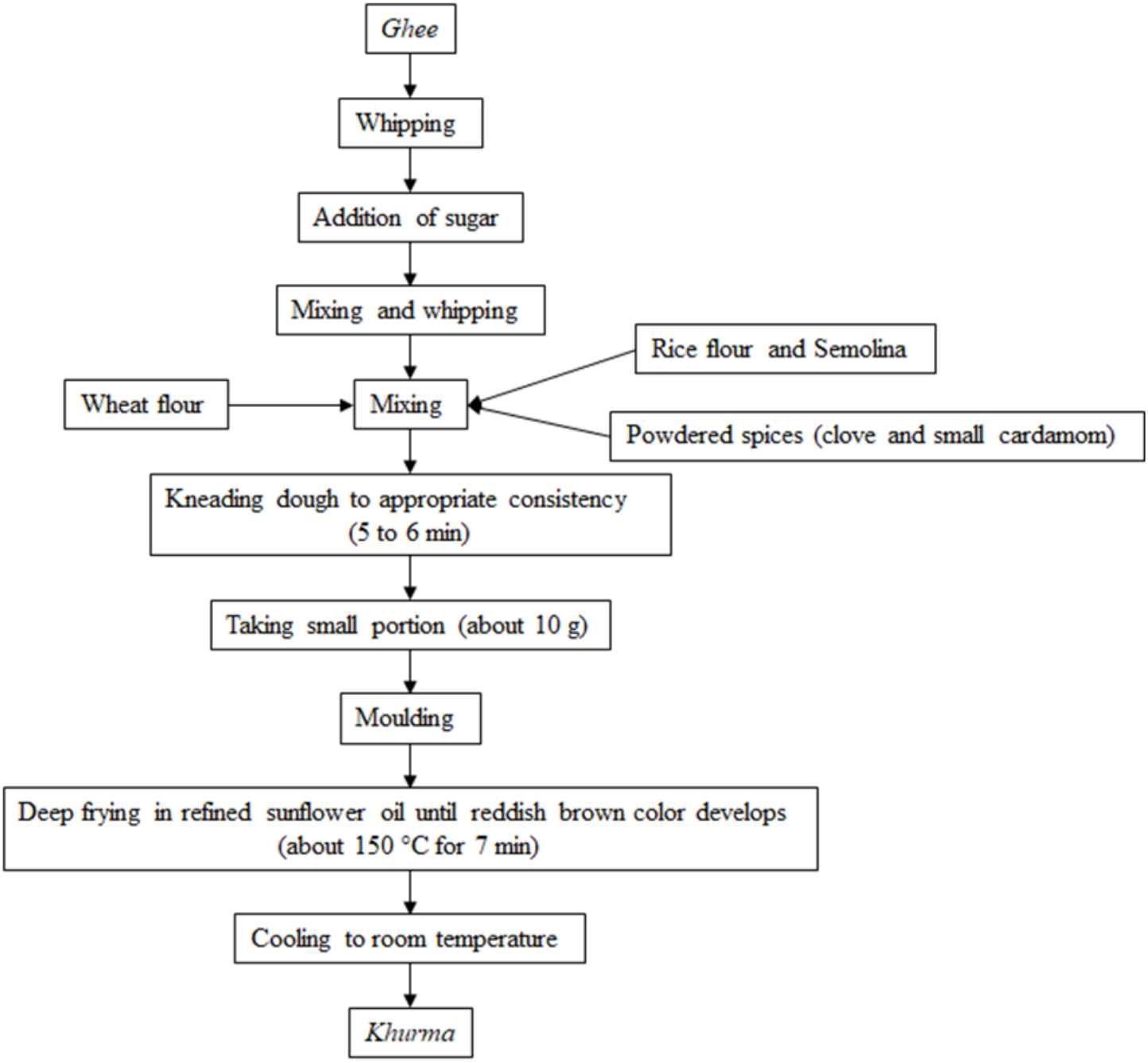

Figure 2

Method for preparation of khurma

Wooden dye with roller Shape after moulding *Khurma*

Figure 3

Mould used preparation of khurma and shape of the product

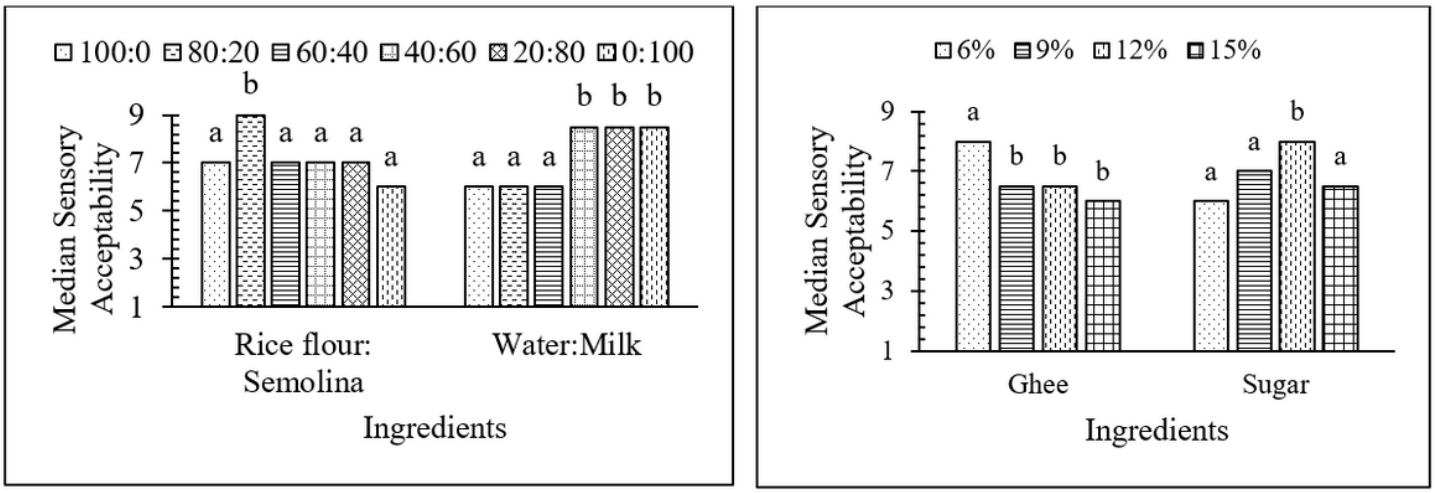

Figure 4

Effects of ingredient variation on overall sensory acceptability of khurma *bars with different alphabet are different at $p<0.05$

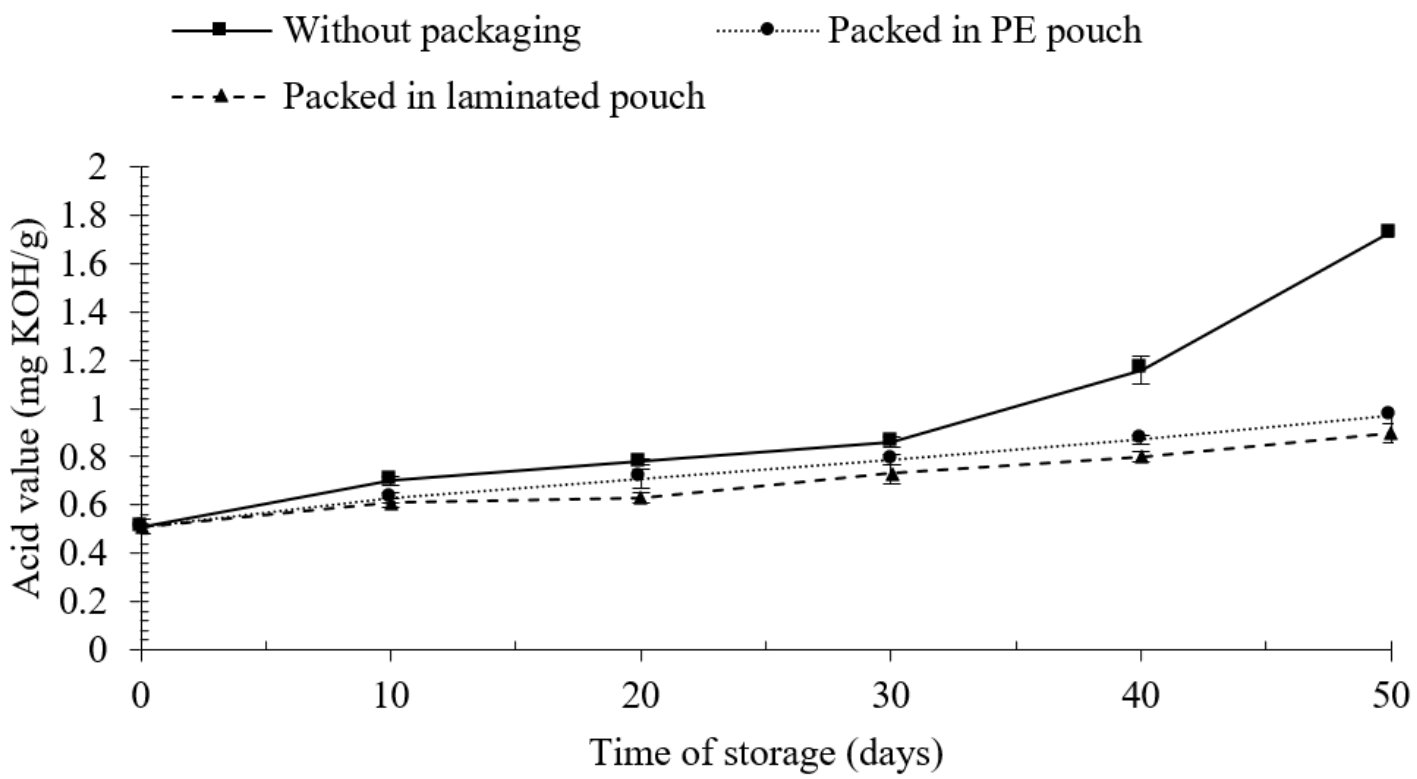

Figure 5

Changes in acid value (AV) with type of packaging and storage period

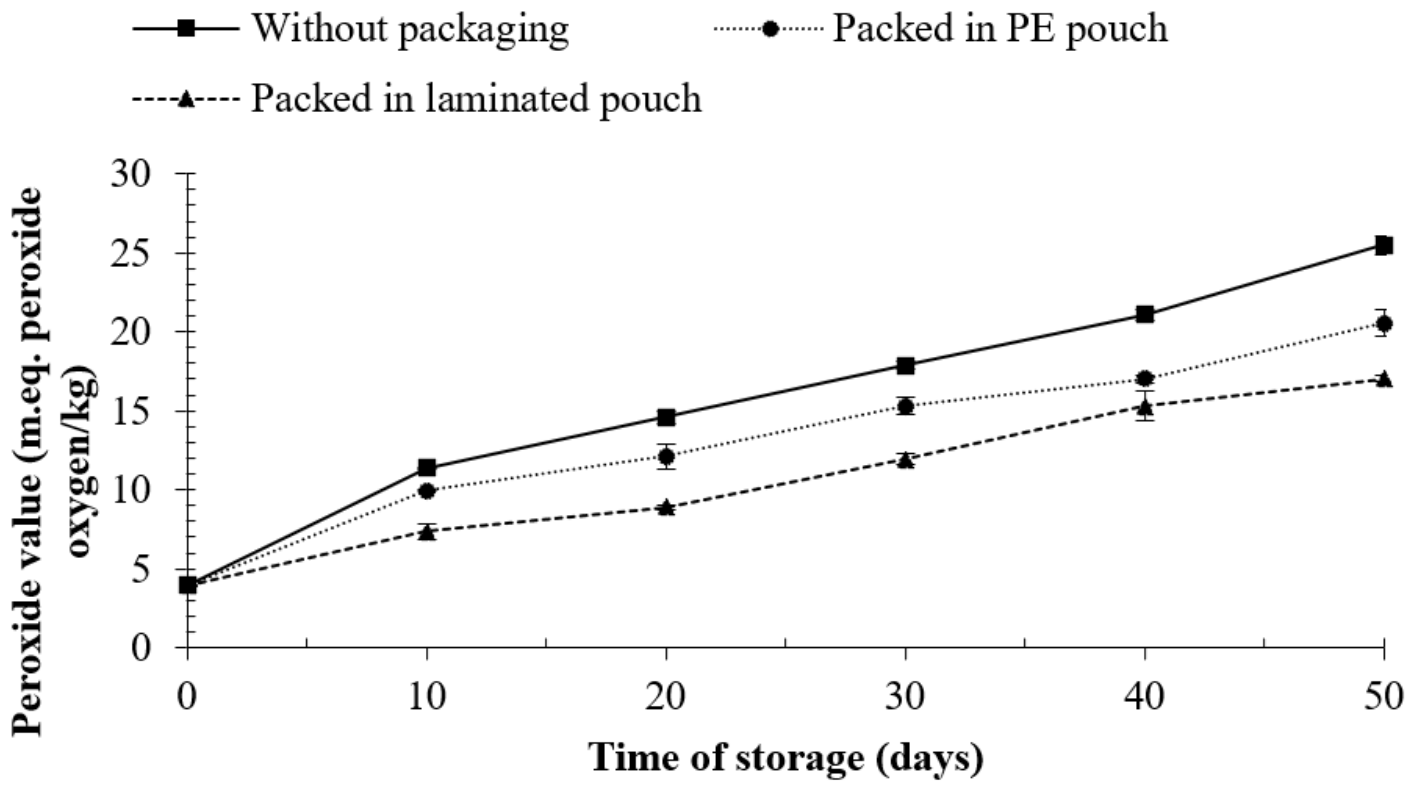

Figure 6

Changes in peroxide value (PV) with type of packaging and storage period