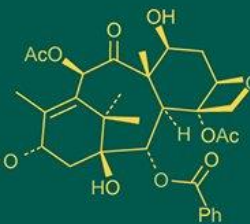
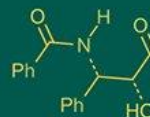


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(3): 22-26
www.biochemjournal.com
Received: 12-01-2026
Accepted: 15-02-2026

Amruta Kumbhar
Under Graduate Student,
Department of Agricultural
Process Engineering, CAET,
VNMKV, Parbhani,
Maharashtra, India

Pramodini More
Assistant Professor,
Department of Agricultural
Process Engineering, CAET,
Parbhani, Maharashtra, India

Mrunmayi Sontakke
Under Graduate Student,
COVAS, Nagpur, Maharashtra,
India

Corresponding Author:
Amruta Kumbhar
Under Graduate Student,
Department of Agricultural
Process Engineering, CAET,
VNMKV, Parbhani,
Maharashtra, India

Effect of size of Osmo-dehydrated carrot shreds on quality of *Redimix* of *Gajarhalva*

Amruta Kumbhar, Pramodini More and Mrunmayi Sontakke

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i3a.7779>

Abstract

Fruits and vegetables contribute a major source of nutrients and are an integral part of the daily human diet. Consumption of carrot in daily diet is increasing day by day due to its high nutritional value and health awareness of people. The traditional method of preparation of *Gajarhalva* is time consuming. Hence, the *Redimix* was formulated using osmo-dehydrated carrot shreds, skim milk powder and coconut meal. The experiment was planned to assess the effect of size of shreds on overall acceptability of *Redimix* of *Gajarhalva* and also to evaluate quality of *Redimix* during ambient storage. A linear correlation was observed in water absorption index with size of carrot shreds. *Ready to serve* form of halva prepared from smaller size shreds showed more stickiness than large shreds. Highest L^* and lowest a^* were observed for *Gajarhalva* prepared from large sized carrot shreds. *Ready to serve Gajarhalva* prepared from medium size carrot shreds exhibited significant overall acceptance. Gradual decrease in the colour of samples was observed during storage. There was not much difference in consistency of stored *Redimix* samples. Aluminium laminated foil indicated very less increase in FFA and water activity values as compared to PET during the storage period of three months.

Keywords: OCD carrot shred, *Redimix*, *Gajarhalva*, ambient storage, overall acceptability

Introduction

Carrot (*Daucus carota* L.) is a major nutrient-dense root vegetable having significant nutritional characteristics. Orange carrots have potent antioxidants due to wide distribution of carotenoids. It exerts anti-carcinogens, anti-diabetic, anti-hypertensive, cholesterol lowering activities and modulates immune response in human body (Mondhe *et al.* 2017; Silva, 2014) [1, 2]. Due to loaded nutritional benefits and a valuable source of natural antioxidants, the consumption of carrots and their products is steadily increasing (Sharma *et al.* 2012) [3]. Apart from being rich in bioactive compounds such as carotenoids and dietary fibres, carrots contains a high percentage of moisture, ranging from 86 to 89%. This high moisture is a major hurdle for shelf life of fresh carrots. The different processing techniques helps to increase its shelf life and make the carrot products available throughout the year for people. *Gajarhalva* is one of the most delicious and popular carrot desserts in Indian food. In the traditional method, the process of *gajarhalva* is tedious and time consuming. But in the last few years, there has been a drastic change in food habits and cooking methods due to urbanization and social modification. People are always in a need of quick, convenient and low time consuming food preparation methods because of busy life style. Ready to cook (RTC) products are the type of foods which are processed or prepared with very little extra efforts. This type of food is becoming popular because of its convenient, time and labour saving nature. The market for RTC/RTE food products in India stood at 261million in 2017 and projected to rich at 647 million (Temgire, *et al.* 2021) [4]. The ingredients which are commonly used in traditional method of *gajarhalva* are carrot shreds, milk or milk powder and ghee. Coconut meal and dry fruits are sometimes used to increase its nutritional as well as sensory value. Vaidya Pallavi (2024) [5] formulated the ready to cook *Redimix* of *gajarhalva* and optimized the levels of orange carrot shreds, coconut meal and skim milk powder using Response Surface Methodology. But it was observed that the size of shreds influences the cooking time and overall acceptance of *gajarhalva*. Generally pink carrots are available in particular period of year but there is year round availability of orange carrots. Hence the experiments were planned to assess the effect of size of shreds on overall

acceptability of *Redimix* of *gajarhalva* prepared from orange carrot. Trials were also carried out to determine the selected quality parameter of *Redimix* of *gajarhalva* at ambient storage condition.

Materials and Methods

Sample preparation

Fresh and firm carrots were purchased from local market. Well matured and uniform sized carrots were peeled and trimmed to remove undesirable top and bottom portion. Peeled carrots were thoroughly washed with water and grated by using a different vegetable grater to prepare the carrot shreds of three sizes as per treatments. Carrot shreds were steam blanched up to for 2 minutes time duration and osmo-convectively dehydrated up to 5% (w b.) moisture content for preparation of *Redimix* (Malik *et al.* 2018; Vaidya *et al.* 2024; Manisha *et al.* 2025; Pramodini *et al.* 2025) [6, 7, 8, 9]. *Redimix* was formulated by incorporating coconut meal and milk powder in osmo-convectively dehydrated orange carrot shreds of different sizes in the proportion of 67:10:27 in 100 g (Vaidya Pallavi, 2024) [5].

Redimix of *gajarhalva* with highest overall acceptance was used for storage study. *Redimix* was packed in aluminium laminated foil (P₁) and PET pouches (P₂) and stored at ambient temperature condition (25 ± °C; 65 ± 4% RH) for 90 days. All stored samples were evaluated for water activity, colour, texture, free fatty acid (FFA) and overall acceptability during storage.

Quality Evaluation

Redimix prepared from orange carrot shreds of different sizes was evaluated for WAI. Other parameters such as the colour, texture and overall acceptability were evaluated in cooked/ready to serve form of *gajarhalva*. Water Absorption Index (WAI) was determined according to (Nguyen *et al.* 2015) [10]. Ready to serve form of *gajarhalva* was prepared by cooking *Redimix* in boiling water with 2:1 ratio of water to *Redimix*. Cooking was carried out about 5 ± 2 min to get required consistency of cooked *gajarhalva*. Consistency of ready to serve form of halva was observed visually. Before serving, it was fortified with ghee and dry fruits for increasing its overall acceptance.

The colour of ready to serve *gajarhalva* was measured in terms of L*, a*, b* value using a Hunter lab Colour Analyzer, Inc. Virginia, USA (Rahman *et al.* 2002) [11]. Texture is one of main quality parameters related to the rheological and

structural properties of food. Textural parameter of cooked *gajarhalva* was measured in terms of consistency a using a Texture Analyzer (Model: TA-XT plus, Stable Micro System, UK). Texture in terms of consistency was determined by using P/75 probe (Bourne, 1978) [12]. Water activity of stored sample was measured by using Aqua Lab Water Activity Meter. Standard method of AOAC (2005) [13] was used to determine free fatty acid in stored *Redimix*. Sensory score indirectly signifies the shelf-life and stability of food products which in turn refers to consumer acceptability. Lighting or darkening of colour, loss of flavour, taste and texture are the major changes that take place in dried food products during storage. Overall acceptability of *Redmix* of *gajarhalva* was considered as average score obtained for various quality attributes like colour, appearance, flavour, texture, and taste of cooked form of halva. Microbial food safety is an essential component of food quality and hence stored samples were evaluated for total plate count by using standard procedure (ISI, 1969) at regular interval of 30 days. Sensory parameters were evaluated with the help of a semi-trained panel using a 9-point Hedonic scale by standard method (ISI) (1971a-1971b).

Results and Discussion

Effect of size of carrot shreds on quality of *Redimix* of *gajarhalva*

The carrot shreds of different size were prepared and osmo-convectively dehydrated for the formulation of *Redimix*. The size of shreds was measured before osmo-convective dehydration and presented in Table 1. The length varied from to be 15.75 to 29.37 mm whereas the width varied from 2.90 to 4.47 mm for S₁, S₂ and S₃ samples respectively.

Table 1: Size of carrot shreds before osmotic dehydration

Sample	Length (mm)	Width (mm)	Thickness (mm)
S ₁ (Small)	15.75	2.90	0.97
S ₂ (Medium)	17.15	3.32	1.03
S ₃ (Large)	29.37	4.47	1.45

Water absorption index is a capacity to absorb water and swell providing desirable consistency. Water absorption index of *Redimix* varied from 2.00 to 2.42 within the treatments. A linear correlation was also observed in WAI with increasing size of carrot shreds. S₃ treatment formed granules in the solution and absorbed more amount of water than S₁ (Small) and S₂ (Medium) shreds.

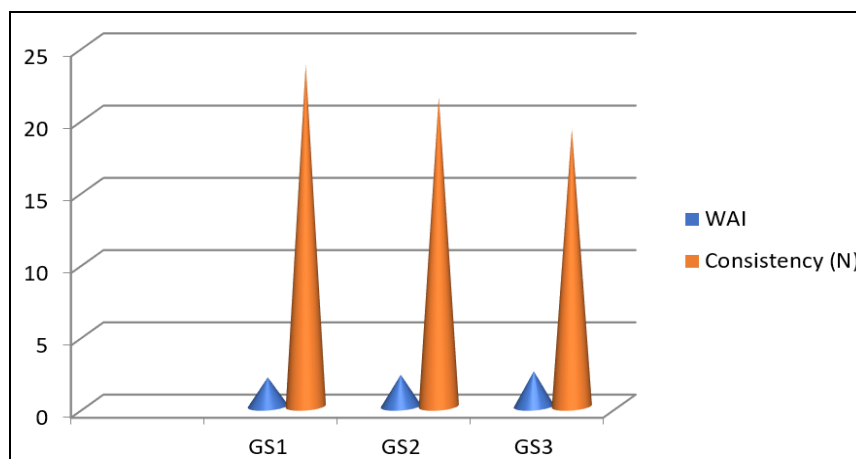


Fig 1: Effect of size of carrot shreds on WAI and consistency of *Redimix* of *Gajarhalva*

Texture was measured in terms of consistency of *Ready to serve* form of *Redimix*. The values of consistency decreased from 23.67 to 19.21 N with increase in size of shreds. It was also observed that *Ready to serve* form of halva prepared from smaller size shreds showed more stickiness while large shred exhibited less stickiness. It might be due to lower sugar gain obtained by the carrot shreds of large size than smaller one during the process of osmosis (Manisha *et al.*, 2025) [6]. Higher sugar gain resulted in more stickiness of cooked *Redimix* during cooking.

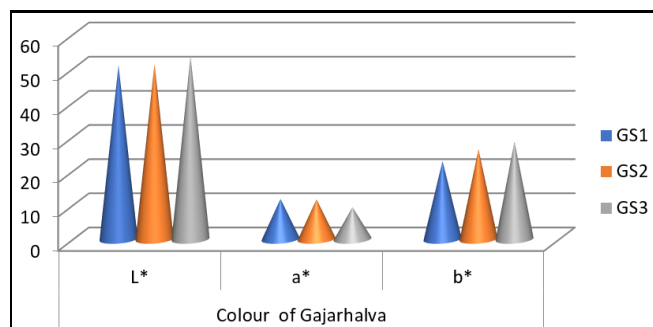


Fig 2: Effect of size of carrot shreds on colour of *Redimix* of *Gajarhalva*

Colour of *Redimix* was determined in terms of L*, a* and b* values of ready to serve form of *gajarhalva*. Highest L* and lowest a* was observed for *Gajarhalva* prepared from large sized OCD carrot shred. Non-significant variation was observed in all three parameters of colour among GS₁ and GS₂ treatments. Reducing and incremental trend in colour value a* and L* respectively with increase in size of carrot shreds might be due to more cooking time required for large size carrot shreds.

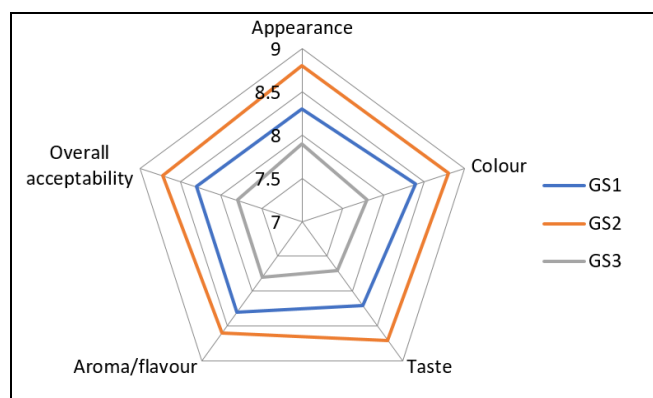


Fig 3: Effect of size of carrot shreds on overall acceptability of *Redimix* of *Gajarhalva*

Overall acceptability is one of the major factors that influence the product acceptance by its multi-dimensional nature. Overall acceptability was determined by considering the score for appearance, colour, taste and aroma/flavour of cooked *gajarhalva*. Fig. 3 showed that *gajarhalva* prepared from medium size carrot shreds (GS₂) exhibited higher score for appearance, taste and aroma/flavour than other two treatments. It might be due to higher consistency of cooked form of *gajarhalva* and considerable sugar gain obtained by medium sized carrot shreds during the process of osmotic dehydration. Overall acceptance of *gajarhalva* prepared from medium size carrot shreds was highest among the other two treatments.

Quality assessment of *Redimix* of *gajarhalva* during ambient storage condition

Fig. 4 illustrates the changes in water activity of *Redimix* of *gajarhalva* stored in aluminium laminated foil and PET pouch at ambient condition for three months. Although samples packed in both packaging showed an incremental changes in water activity, but the increase was higher in PET pouches than aluminium laminated foil. Increase in water activity of stored samples resulted from the moisture gain by the sample during storage. Changes in water activity were negligible up to 45 days of storage. Overall higher changes were observed for PET packaging as compared to ALF. Similar higher changes in water activity were observed by Loo and Pui (2020) [14] for kuini powder stored in polyethylene terephthalate than aluminium laminated polyethylene. However noted values of the water activity for both the packaging material are far below than the critical limits (Mithila *et al.* 2020; Farminin and Nordin, 2009) [15, 16].

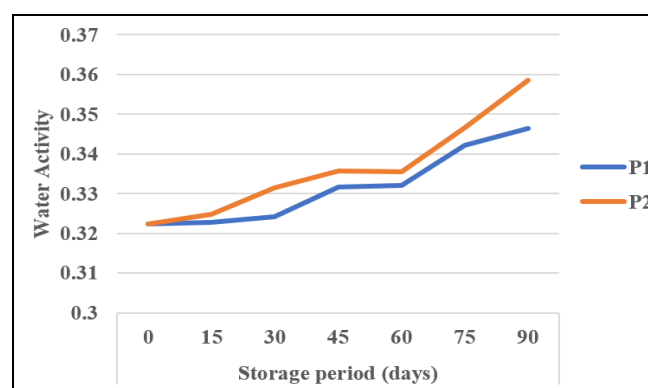


Fig 4: Changes in water activity of *Redimix* of *Gajarhalva* during ambient storage

From Fig. 5, it is indicated that lightness values (L*) of *Ready-to-Serve* form *Gajarhalva* exhibited gradual increase with advance in storage period. While colour values a* showed decreasing trend for samples packaged in both packaging material. The maximum colour change was observed in samples stored in PET than aluminium laminated foil. Better retention of colour was observed for ALF than PET at the end of storage period of three months.

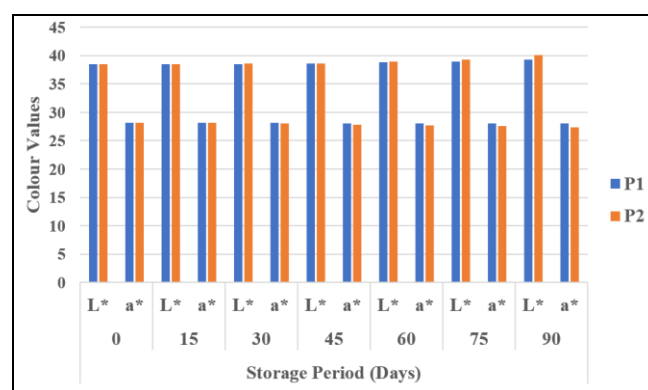


Fig 5: Changes in Colour of *Redimix* of *Gajarhalva* during ambient storage

Texture is comprised of those properties of a product that can be appraised visually or by touch. Fig. 6 represents the texture (consistency) of *Ready-to-Serve* form of *Gajarhalva*. The values of consistency varied from 22.13 to 21.00 N

during storage period of three months. Overall decrease in values of consistency was observed over the storage period of three months. These reductions in textural values might be due to the increase in water activity of the stored

Redimix. However non-significant difference was noticed for both the samples during ambient storage of three months.

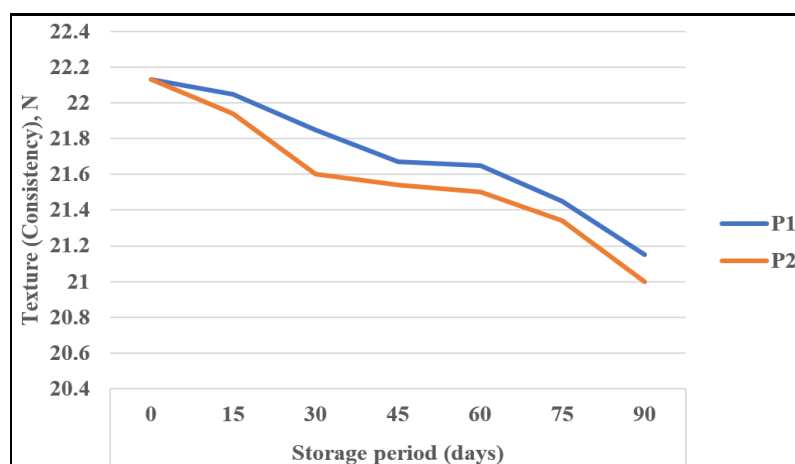


Fig 6: Changes in consistency of *Redimix* of *Gajarhalva* during ambient storage

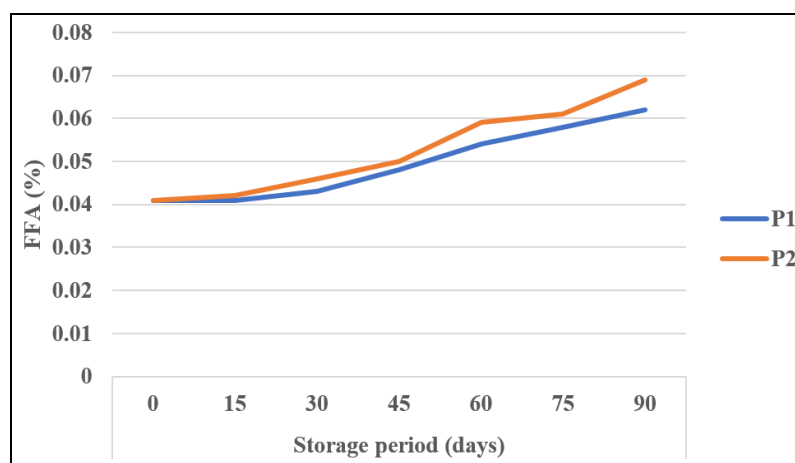


Fig 7: Changes in free fatty acid (FFA) of *Redimix* of *Gajarhalva* during ambient storage

Free fatty acid (FFA) content is considered to be an indicator of oil quality in food. It leads to development of off flavour in food especially in dairy products. *Redimix* stored at ambient conditions were analysed for FFA and results are presented in Fig. 7. The value of FFA increased from 0.01 to 0.069 over the storage period. Khan *et al.* (2019) ^[17] was also observed a similar increasing trend in FFA values of instant rice porridge mix formulated by using

skim milk powder during storage. The change in these values was very small or negligible up to 45 days of storage. After 45 days, sample stored in PET material exhibited higher values than the sample stored in ALF. Increase in water activity of stored sample led to increase in FFA values during storage. Moisture was an important factor affecting shelf life as it triggers other quality parameters such as FFA, water activity and microbial load (Mithila *et al.* 2020) ^[15].

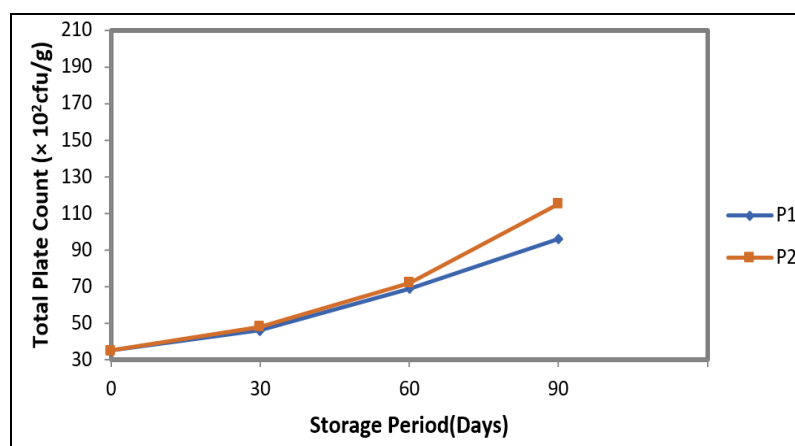


Fig 8: Changes in Total plate count (cfu/g) of *Redimix* of *Gajarhalva* during ambient

Total plate count is most commonly used to evaluate microbiological quality of a food. Osmo-convectively dehydrated fruits and vegetable products generally have very low moisture content and water activity. Therefore, change in total plate count of stored samples was examined at an interval of 30 days and data is presented in Fig. 8. Total plate count of samples was increased slightly up to 115×10^2 cfu/g at the end of 90 days of storage period. Overall gradual increase in total plate count was observed with increased storage period. However, observed values of TPC of *Redimix* stored in both packaging material were far below the critical level of 1×10^5 cfu/g during the storage period of three months (Mithila *et al.* 2020; FAO, 2001) [15, 18]

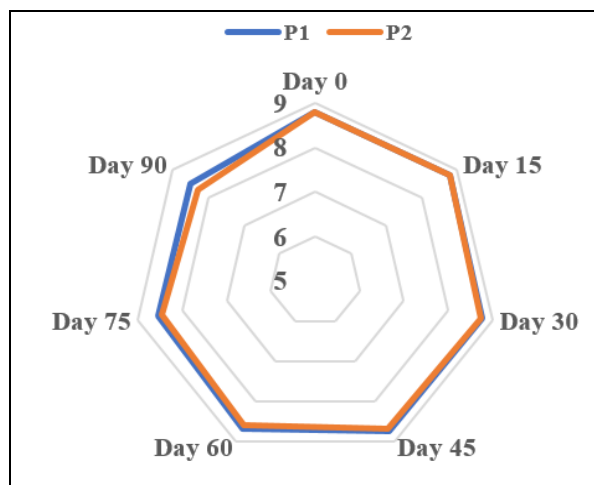


Fig 9: Changes in overall acceptability of *Redimix* of *Gajarhalva* during ambient storage

Sensory score of overall acceptability for *Redimix* packed in ALF and PET packaging material during ambient storage is illustrated by Fig. 9. Both the stored samples were acceptable during the storage period of three months. Considerable changes were not observed in all the sensory parameters except colour. Reducing trend in overall acceptability of both samples was due to decrease in the score of colour parameters of cooked form of *gajarhalva*. *Redimix* packed in aluminium laminated foil obtained higher overall acceptance than the sample packed in PET pouch at the end of storage period of three months.

Conclusion

Considering the FFA and overall acceptability, *Redimix* of *Gajarhalva* stored in Aluminium laminated foil and PET pouches at ambient conditions were acceptable during storage period of three months. Aluminium laminated foil indicated very less increase in FFA and water activity values as compared to PET pouches.

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