Original Research Article

Analysis of the functional characteristics and costs of carrot-sooji halwa mix

ABSTRACT

Carrot is a root vegetable that belongs to the Apiaceae family and the botanical names Daucus carota and Genus Daucus. Carrot is a globally important vegetable crop that provides essential bioactive constituents such as carotenoids, anthocyanins, and other phenolic compounds. Due to the presence of these compounds, carrot is considered as a functional food with potential health benefits for human. In the current investigation, carrot flour was used to create a instant carrot-sooji halwa mix. Carrot flour and semolina were combined to make halwa mix, which was then placed in pouches made of laminated aluminum and packed in the following ratios: 100:0, 90:10, 80:20, 70:30, 60:40, and 50:50. The functional characteristics of water absorption capacity, oil absorption capacity, swelling capacity bulk density, foam capacity and foam stability were assessed using accepted methods. Increased semolina inclusion with carrot flour resulted in a decrease in the functional qualities of the halwa mix, such as water absorption capacity, oil absorption capacity, swelling capacity, and bulk density. The cost of carrot-suji halwa mix of different treatments was observed highest for C_{100} followed by C_{90}, C_{80}, C_{70}, and C_{60}, and lowest for C_{50}. The cost of halwa mix was decreased with an increase in the incorporation of semolina with carrot flour.

Keywords: bulk density, foam capacity, foam stability, swelling capacity, water absorption capacity, oil absorption capacity, and swelling capacity.

1. INTRODUCTION

In order to optimize the genetic potential of humans, nutritional well-being is a sustainable force for health and development. A lack of proper food intake, either in terms of quantity or quality, affects the population of many Indian states, including Tamil Nadu, Andhra Pradesh, Karnataka, Bihar, and West Bengal. Blindness is one of vitamin A deficiency's (VAD) most harmful and catastrophic health effects **[1].**

Drying is one of the most relevant and challenging processes of food industry, since a great number of food products are subjected to at least one drying step during its production solid **[2,3].** The main purposes of drying crops are to increase its shelf life, to better its quality, to simplify the handling, storage and transport of the products and also to prepare the product to subsequent processes. To preserve the vegetables over a period of long time for use during off-seasons, dehydration is one of the most important methods, because it lowers the cost of packaging, storage and transportation by reducing both the weight and volume of the final product**[4].**

Carrot roots are one of a kind roots that are rich in carotenoids and have a unique flavour from terpenoids and polyacetylenes. Sesquiterpenoids and monoterpenoids predominate among terpenes, while polyacetylenes are made up of falcarinol molecules. Because of the slow production of sugars in the root during growing, the bitter carrot flavour is subdued to an acceptable extent. Red, orange, yellow, purple, black, and white roots are produced as a result of the variation in the pigments**[5].** The pigments found in various colored roots have wide-ranging medical benefits for human health. For example, the lutein in yellow carrots helps to create the macular pigments needed for appropriate eye function [6]. The lycopene present in tomatoes and the red varieties of carrot**[7]**has a powerful singlet oxygen scavenging activity **[8]** and its high levels in the blood plasma have an impact on lowering down the risk of various cancers **[9].** The black or purple color of carrots is attributed to the presence of anthocyanins known to antioxidants**[6].**

Semolina has a calorific content of 372 kcal/100g and is made up of 70.9% carbohydrates, 12.3% proteins, 4.4% fats, and 11.6% moisture. Semolina also has a low glycemic reaction, which makes it a tasty and healthful option **[10].**For a huge portion of the Indian population, wheat serves as their primary source of protein and calories. The majority of the wheat grown in India is used to make chapaties and other bread goods. However, in response to shifting dietary trends, wheat is ground into semolina that is used to make both sweet and savory dishes**[11].**

To improve the qualitative qualities of instant food mixes, different combinations of processed cereals, pulses, and other food items are included. These are used to quickly and easily prepare a variety of food products. In recent years, these goods have gained more and more favor with modern ladies.At present Indian food market is witnessing a wide range of instant food mixes. Dry mixes of several traditional mixes such as multigrain halwa mix**[12],** instant Khadi mix**[13],** instant khichadi mix**[14],**instant ravaidli mix**,** instant vegetable pulav mix **[15]** and instant sooji upma mix**[16]**are generally available.

Halwa refers to many types of dense, sweet confections. It is a type of dessert with the consistency of a very thick pudding, made from various kinds of fruits, vegetables, grains, nuts and lentils. It is generally prepared from various raw materials like fine suji (semolina) from wheat, mung dhal, chick pea, carrot. Halwa mixes can be stored for 75 days under accelerated and 180 days under ambient conditions. In India, there are different types of desserts like Nauki halwa, Carrot halwa, Mung dhal halwa, Bombay halwa etc. In North India, the product-halwa is yellow brownish in colour, opaque, soft and smooth in texture, while in Southern India it is a jelly like translucent product with luster. It is not very easy to prepare halwa, as the raw materials specifications, their proportion, sequence of adding and processing steps are rather specific. Moreover, the halwa is normally rich in fat and sugar, but not satisfactory in other nutrients **[17, 12].** Therefore, supplementing them with other nutritionally dense food products, improves the nutritional quality of halwa by complementing their limited amino acids, lysine and tryptophan **[18, 19]**.

2. MATERIAL AND METHODS

2.1.Evaluation of functional properties of flours and instant carrot-sooji mix

The functional properties of flours were analyzed i.e. swelling capacity (ml), water absorption capacity (WAC, %), oil absorption capacity (OAC, %), foam capacity (FC, %), foam stability (FS, %), and bulk density (g/cc).

The water absorption capacity was determine by the method of **[20] Sosulski*et al*., (1976).**One gram of sample mixed with 10 ml. distilled water and allow to stand at ambient temperature (30±2^{0}C) for 30 min, the centrifuged for 30 min at 3000 rpm or 2000 x g. Water absorption was examined as percent water bound per gram flour.
The fat absorption capacity was determine by the method of **[20] Sosulski*et al.*, (1976).**One gram of sample mixed with 10 ml. soybean oil (Sp. Gravity 0.9092) and allow to stand at

ambient temperature (30 ± 2^0C) for 30 min, the centrifuged for 30 min at 300 rpm or 2000 x g. Fat/oil absorption was examined as percent fat/oil bound per gram flour.

The swelling capacity was determined by the method described by**[21] Okaka and Potter (1977).** 100 ml graduated cylinder was filled with the sample to 10 ml. mark. The distilled water was added to give a total volume of 50 ml. The top of the graduated cylinder was tightly covered and mixed by inverting the cylinder. The suspension was inverted again after 2 min and left to stand for a further 8 min. the volume occupied by the sample was taken after the 8^{th} min.

The volume of 100 g of the meals was measured in a measuring cylinder (250 ml.) after tapping the cylinder on a wooden plank until no visible decrease in volume was noticed, and based on the weight and volume, the apparent (bulk) density was calculated**[22] (Jones *et al*., 2000).**

The foam capacity (FC) and Foam stability (FS) were determined as described by **[23] Narayana and Narasinga Rao (1982)** with slight modification. The 1.0 g flour sample was added to 50 ml. distilled water at 30 ± 2^0C in a graduated cylinder. The suspension was mixed and shaken for 5 min to foam. The volume of foam at 30 sec after whipping was expressed as foam capacity using the formula:

$$\text{Foam capacity (\%)} = \frac{\text{Volume of foam AW} - \text{Volume of foam BW}}{\text{Volume of foam BW}} \times 100$$

Where,

AW = after whipping, BW = before whipping

The volume of foam was recorded one hour after whipping to determine foam stability as per percent of initial foam volume.

2.2. Cost Analysis

Cost analysis involves assessing or examining topics or issues or issues from an economist's perspective. It may also be a study of production process or an industry. The analysis aims to determine how effectively the economy or something within it is operating. For example, an economic analysis of a company focuses mainly on how much profit it is making. An economic analysis is a process in which business owners gain a clear picture of the existing economic climate, as it relates to their company's ability to thrive.

2.2.1. Cost of Production

Cost of production refers to the total sum of money needed for the production of a particular quantity of output. As defined by **Gulhrie and Wallace**, "In economics, cost of production features a special meaning. It is all about the payments or expenditures essential to get the factors of production of land, labour, capital and management needed to produce a commodity. It signifies the money costs which are to be incurred for acquition of the factors of production.

2.2.3. Fixed Costs

Fixed cost are those that do not vary with output and typically include rents, insurance, depreciation, set-up costs and normal profit. They are also called overheads.

2.2.4. Variable Costs

Variable cost are costs that do vary with output, and they are also called direct costs. Examples of typical variable costs include fuel, raw materials and some labour costs.

The general formula used for computing production cost are:

Production cost per item = Fixed cost (FC) + Variable cost (VC) / No. of units produced.

2.3. Development of Carrot Flour

The carrot was purchased from the local market, cleaned, peeled, and chopped into little cubes before being blanched and dried. To inactivate the enzyme polyphenol oxidase, carrot cubes were blanched for five minutes in hot water. Small cubes were dipped in tap water after five minutes. After blanching, small cubes were grated, dried at 60°C in a tray dryer for 6-7 hours in the dark until no weight change was visible, and then finely pulverised by a food processor. The pulverised powder was put through a 0.40mm mesh filter and stored in a PET Jar at room temperature.

2.4. Development of Instant Carrot-Sooji halwa mix

Carrot-suji halwa mix were prepared by incorporation of carrot flour, and semolina blends in ratios of 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50, respectively. Different ratios of semolina and carrot flour were weighed. The ingredients such as semolina were first roasted (150°C) in desi ghee separately in an open pan for 2-3 minutes or till light brown color and then allowed to cool at room temperature and were mixed properly in the different ratio with carrot flour, powdered sugar (40g) and milk powder (40g). The products were packed in aluminum laminated pouches (ALP) at ambient temperature.

3. RESULTS AND DISCUSSION

3.1. Water Absorption Capacity (WAC)

Water absorption capacity (WAC) consists of adding water or an aqueous solution to material, followed by centrifugation and quantification of the water retained by the pelleted material in the centrifuge tube **[24]**. Water absorption capacity is referring to the ability of the flour or starch to hold water against gravity that can comprise of bound water, hydrodynamic water, capillary water and physically entrapped water **[25]**. The water absorption capacity for carrot flour and semolina is given in Table 1. The WAC was observed highest in carrot flour (617.66%) and lowest in semolina (74.3%). In the halwa mix water absorption capacity in different combination decreased with increase in the level of incorporation ratio of semolina in carrot flour. The result suggests that addition of semolina to carrot flour decreased the amount of water absorption in halwa mix. This could be due to molecular structure of the semolina which inhibited water absorption, as could be seen from the lower values of WAC, with increase in proportions of semolina to carrot flours. Similar observation was reported by **[26] Kaushal *et al.,* (2012).** From the Table 1, It was also observed that the score of WAC in halwa mix was decreased by the roasting of semolina at 150°C in ghee and mix that roasted semolina in other in gradients of halwa mix then the layer of ghee is formed on halwa mix which oppose the entry of water in halwa mix therefore, the WAC (72-165%) is decreased in halwa mix as compared to the flours (617% and 74%).In view of above, the roasting of semolina in ghee affects the water absorption capacity of halwa mix.

3.2. Oil Absorption Capacity (OAC)

The oil absorption capacity for flours is given in Table 1. The OAC was observed highest in carrot flour (90.03%) and lowest in semolina (89.66%). In the halwa mix oil absorption capacity in different combination decreased with increase in the level of incorporation ratio of semolina in carrot flour.The result observed that addition of semolina to carrot flour decreased the amount of oil absorption in halwa mix. The highest value showed in control i.e. $C_{100}S_0$ **(**85.33%) and lowest in $C_{50}S_{50}$ (73.66%).From the data Table 1, It may also clear that the score of OAC in halwa mix was decreased by the roasting of semolina at 150°C in ghee. In view of above, the roasting in ghee of semolina affects the oil absorption capacity of halwa mix. The OAC is important since oil act as flavor retainer and increases the mouth-feel of foods**[27]**. However, the flours in the present study are potentially useful in structural interaction in food specially in flavor retention, improvement of palatability and extension of shelf life particularly in products where fat absorption is desired**[27]**. The major chemical component affecting OAC is protein which is composed of both hydrophilic and hydrophobic parts. Non-polar amino acid side chains can form hydrophobic interaction with hydrocarbon chains of lipids**[28]**.

3.3. Swelling Capacity (SC)

The swelling capacity (SC) for flours is given in Table 1. The SC was observed highest in carrot flour (3.23g/ml) and there is no SC in semolina. The ability of flours to swell is influenced by particle size, kind of variety, and type of processing technique. The result observed that addition of semolina to carrot flour means the amount of carrot flour ratio is decreased. The Swelling capacity also decreased as carrot flour decreased in all the different composition of halwa mix while semolina had no swelling capacity presented in Table 1. The highest value showed in control i.e. $C_{100}S_0$ **(**1.46g/ml) and lowest in $C_{50}S_{50}$ (0.16g/ml).In the halwa mix, swelling capacity in different combination decreased (as shown in Table 1) with increase in the level of incorporation ratio of semolina in carrot flour. The SC was also affected by roasting of semolina in ghee.

3.4. Bulk Density

The bulk density for flours is given in Table 1. The bulk density was observed in carrot flour (0.78g/cm^3) and there is no bulk density in semolina. The result observed that addition of semolina to carrot flour means the amount of carrot flour ratio is decreased so the bulk density was also decreased as the carrot flour decreased in all the different composition of halwa mix because semolina was detected no bulk density. The highest value showed in control i.e. $C_{100}S_0$ **(**0.731g/cm^3) and lowest in $C_{50}S_{50}$ (0.681g/cm^3). In the halwa mix bulk density in different combination decreased (as shown in Table 1) with increase in the level of incorporation ratio of semolina in carrot flour. It is clear that decreased the proportion of semolina increase the bulk density of halwa mix. The high bulk density of flour suggests their suitability for use in food preparations. On contrast, low bulk density would be an advantage in the formulation of complementary foods **[29].**

3.5. Foaming Capacity

The term "foam capacity" describes how much interfacial area a protein can produce **[30].** Foam is a colloidal made up of many gas bubbles that are contained in a liquid or solid. There are thin liquid sheets all around tiny air bubbles. The foaming capacity for flours is given in Table 1. The foaming capacity was observed in carrot flour (6.2%) and in semolina (10%). The study investigated that due to addition of other in gradients i.e. milk powder, sugar powder, cardamom powder and semolina roasted in ghee into carrot flour, affected the foaming capacity of halwa mix. In view of above, the foaming capacity of halwa mix was not determined by the procedure as presented in Table 1 due to addition of ghee and other in gradients.

3.6. Foaming Stability

The term "foam stability" (FS) refers to a protein's capacity to withstand mechanical and gravitational stresses **[30].** The foaming stability for flours is given in Table 1. The foaming stability was observed in carrot flour (0) and in semolina (40.4%). The study investigated that due to addition of milk powder, sugar powder, cardamom powder and semolina roasted in ghee into carrot flour, affected the foaming stability of halwa mix. In view of above, the foaming capacity is not determined in the product then foaming stability of halwa mix was also not determined by the procedure as presented in Table 1 due to addition of ghee and other in gradients.

Table 1: Functional properties of flours and different composition of instant carrot-sooji halwa-mix.

Sample (flour)	Water Absorption Capacity, (%)	Oil Absorption Capacity, (%)	Swelling Capacity, (g/ml)	Bulk Density, (g/cm^3)	Foaming Capacity, (%)	Foaming Stability, (%)
Carrot flour	617.66±2.51	90.03±3.05	3.23±0.25	0.78±0.03	6.2±1.05	ND
Semolina	74.3±1.52	89.66±2.51	ND	ND	10±0.2	40.4±0.36
Carrot-suji halwa mix with other in-gradients						
$C_{100}S_0$	165±2.00	85.33±1.52	1.46±0.15	0.731±0.018	ND	ND
$C_{90}S_{10}$	161.33±1.52	82.83±0.28	1.10±0.10	0.714±0.02	ND	ND
$C_{80}S_{20}$	151.33±1.52	81.8±0.28	0.76±0.57	0.707±0.008	ND	ND
$C_{70}S_{30}$	115.66±1.52	80±1.00	0.56±0.57	0.697±0.006	ND	ND
$C_{60}S_{40}$	74±1.00	77±1.00	0.36±0.57	0.691±0.008	ND	ND
$C_{50}S_{50}$	72.66±1.52	73.66±1.52	0.16±0.57	0.681±0.009	ND	ND

ND- Not Determined

3.7. Cost analysis of instant carrot-sooji halwa mix

The data regarding cost (Rs/kg) of control and experimental carrot-suji halwa mix of different treatments are presented in Table 2. The cost of halwa mix was observed for C_{100} 796.8 Rs/kgamong all the samples. The highest cost was observed for C_{100} (796.8) and the lowest for $C_{50}S_{50}$ carrot-suji halwa mix (734.8). It was noted that the carrot-suji halwa mix of different treatments highest cost was observed for C_{100} (796.8) followed by C_{90} (784.4), C_{80} (772), C_{70} (759.6), C_{60} (747.2) and lowest for C_{50} (734.8). The cost of halwa mix was decreased with increase in the incorporation of semolina with carrot flour.

Table 2: Cost estimation of Instant Carrot-Sooji Halwa-mix with different composition

Ingredients	Amount required for 1000 g (g)						Rate in Rs./Kg	Halwa mix Cost in Rs.					
	C_{100}	C_{90}	C_{80}	C_{70}	C_{60}	C_{50}		C_{100}	C_{90}	C_{80}	C_{70}	C_{60}	C_{50}
Carrot Flour	400	360	320	280	240	200	350	140	126	112	98	84	70
Semolina	-	40	80	120	160	200	40	-	1.6	3.2	4.8	6.4	8
Sugar powder	100	100	100	100	100	100	40	4	4	4	4	4	4
Milk powder	100	100	100	100	100	100	228	22.8	22.8	22.8	22.8	22.8	22.8
Cardamom powder	10	10	10	10	10	10	3500	35	35	35	35	35	35
Desi ghee	390	390	390	390	390	390	500	195	195	195	195	195	195
Fixed and Variable cost Excluding ingredient @ 7.5 % of cost of ingredients							400	400	400	400	400	400	400
Total weight (gm)	1000	1000	1000	1000	1000	1000	**Cost Rs./Kg**	796.8	784.4	772	759.6	747.2	734.8

4. CONCLUSION

The purpose of the present investigation was to assess the functional qualities of flours and halwa mix as well as do a cost analysis of the halwa mix. Carrot flour showed highest in water absorption capacity, oil absorption capacity, swelling capacity and bulk density; semolina found highest in foam capacity and foam stability. The halwa mix, of C_{100} ratio was resulted highest in water absorption capacity, oil absorption capacity, swelling capacity and bulk density while foam capacity and foam stability was not determined by the procedure in any composition ratio of halwa mix. In case of cost of halwa mix, the highest cost was observed for C_{100} and the lowest for $C_{50}S_{50}$.Incorporation of semolina to carrot flour to make instant halwa mix would therefore be an effective method of cost reduction of instant halwa mix and other value added products and solving malnutrition problem of children as well as production and utilization of semolina for benefit to farmers and industrialists.

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