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Effect of Osmotic dehydration on quality of pumpkin flour

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Abstract—*Pumpkin is widely used as a valuable food source and is gaining much attention in healthcare of consumers. Dried pumpkin powder is an alternative way to increase the consumption. For this reason, a sound knowledge of the processes for drying and powdering of pumpkin is needed. Therefore, the present paper summarizes data from the literature and focuses mainly on Hot air drying process of dried pumpkin cubes, including pre-treatment technique which can influence the quality of dried product. Osmotic dehydration is the best suitable method for pretreatment which is used to improve the quality of finished product. Pretreated pumpkin cubes are dried using Hot air dryer (70℃) to achieve better quality of dried pumpkin cubes. OD pretreatment was carried out in salt solutions of 5, 10 and 15 % for varying time interval (0, 30, 60, 90, 120 and 150) min. each. Proximate analysis (moisture content, protein, fiber, ash, fat , carbohydrate and vitamin C) was determined along with physiochemical properties (TSS, titratable acidity, color, pH) of dried pumpkin cubes powder. The solution concentration and pretreatment time had significant effects on weight reduction, water loss, and solid gain of pumpkin. On the basis of findings, it is observed that the osmotic dehydrated pumpkin powder resulted in better quality and can be further incorporated into various food products developments.*

1. INTRODUCTION

Pumpkin (*Cucurbita maxima*) is a genus of herbaceous vines, belonging to the *Cucurbitaceae* family and is characterized by prostrate or climbing herbaceous vines with tendrils and large fleshy fruits containing numerous seeds. In India, the pumpkin is commonly known as 'sitaphal', 'kashiphal' or 'lal kaddu .The pumpkin species available include *Cucurbita pepo, Cucurbita moschata, Cucurbita maxima, Cucurbita facifola* and *Telfairia occidentali*. Among these *C. pepo, C. moschata and C. maxima* are cultivated worldwide and have high production yields.

The main growing season of Pumpkin is summer and rainy seasons in most parts of India. Winter pumpkins are also grown in some parts of Southern and Western India [1] . The production statistics reveal that China is one of the leading producers of pumpkin in the world with the overall production of 19511.15 MT [2]. Pumpkin is considered to be one of the important vegetable crops where immature and mature fruits, tender leaves and flowers are processed in one or the other form.

Pumpkins are cooked and consumed in many ways, and most parts of the pumpkin are edible, from the fleshy shell to the seeds. Its physical structure is a large berry with a hard shell and fleshy pulp, yellow-orange in color, dense, with a firm texture and sweet flavor, particularly striking for different gastronomic preparations; from a nutritional point of view, it has low concentrations of carbohydrates (8.8%) compared to other vegetables, protein around (1%) fat near (0.5%), and fiber at (1%). Pumpkin is also rich in minerals such as potassium (439 mg), calcium (26 mg), and phosphorus (17 mg) [3-5] Pumpkin is a good source of carotene, pectin, minerals, vitamins and other substances that are beneficial to health, it also contain bioactive compounds that have a protective role against many diseases, including hypertension, diabetes, cancer and coronary heart diseases. The pulp present in fruit is used to relieve intestinal inflammation or enteritis, dyspepsia and stomach disorder.

Fruits and vegetables are highly short-lived foods. They easily degrade due to the bacterial proliferation and because of the presence of high moisture content in them. Therefore, dehydration processes in fruits and vegetables prolong their shelf life, by reducing water content and enzymatic and microbiological activity, but they may significantly affect bioactive compounds such as vitamins, antioxidant activity, and phenolic compounds. Pretreatment method carried out before drying influence the concentrations of these compounds, possibly due to structural changes in the food that facilitate the dehydration process as well as enzymatic inactivation [6].

Various conventional methods such as tray hot air drying, convective air oven drying, vacuum drying, freeze drying, etc.

have been used for their preservation. Among these methods tray drying is gaining much attention and is mostly used for this purpose. Currently, the hot-air tray drying method results in a uniform, quality, hygienic, and attractive color of dried product which can be produced rapidly. Dried pumpkin powder is great source to increase pumpkin consumption by providing an alternative to fresh pumpkins. Dried pumpkin powder products have advantage of storage and transportation over fresh pumpkin due to their longer shelf lives.

The prolonged thermal drying though has some adverse effect on dried products and cause nutritional losses too. Therefore, in order to minimize the deteriorative effects of thermal drying and to optimize the moisture desorption, some pre-treatments such as osmotic dehydration, have been suggested with the objective to produce a product of intermediate moisture content product. Osmotic dehydration (OD) is a food preservation technique, reducing flavor loss and color change due to heat, inhibiting the enzymatic browning, and decreasing the energy costs [7-8]. OD is simultaneous a mass transfer process which mainly promotes the flow of water molecules from the food to osmo-active solution and some migration of solutes from the solution into the food, thus maintaining good organoleptic and functional properties in the finished product. Osmotic dehydration has diverse applications in fruits and vegetables. Thus it can be used to decrease the post-harvest losses. Being a simple process, it facilitates processing of fruits and vegetables with retention of initial fruit characteristics viz., colour, aroma, texture and nutritional composition. The drying of pumpkin (with and without OD) has been investigated by several authors. [9] applied osmotic drying prior to convective drying. [10] studied combination of osmotic dehydration and vacuum drying; [11] employed initial partial freeze-drying followed by terminal hot air drying; whilst [12] reported microwave dehydration of pumpkin. In this study main focuss on the use of Osmotic Dehydration as a pretreatment method with salt as osmotic agent and drying of pretreated pumpkin cubes to obtain smooth powder.

2. MATERIALS AND METHODS

2.1 Raw Material

Pumpkin (*Cucurbita maxima*) used for the experiment was purchased from local market. Pumpkins were washed, hand peeled, and seeded. The zone near the peel was removed using peeler, and the pulp was cut into cubes of 2×2×2 cm^3 using slicer. The initial moisture content of pumpkin was determined on (wet basis) by conventional method.

2.2 Osmotic Dehydration Pretreatment

Pumpkin cubes were weighed and dip into osmotic solution in beaker of (5, 10, 15% salt w/w). The ratio of fruit to osmotic solution was maintained at 1:4 (w/v). The prepared samples were kept in osmotic solution and left for about 30 min for osmosis. The pretreated samples were then blotted gently on the blotting paper to remove the excess moisture. After the removal of excess moisture the pretreated samples were again weighed to observe the WR, WL and SG respectively. In addition, dry matter values of pretreated samples were determined by drying up to the establishment of constant weight in a convection oven at 105°C [13] for the determination of water loss (WL) and solid gain (SG).Weight reduction (WR), water loss (WL), and solid gain (SG) of pumpkin cubes subjected to osmotic dehydration pretreatment were calculated according to the following equations, respectively,

$$MR=\frac{Mo-Mt}{Mo}\times 100$$

$$WL(g\,\frac{water}{g}\times initial\ mass)=\frac{Mo\times Xiw-Mt\times Xiw}{Mo}\times 100$$

$$SG(g\,\frac{solid}{g}\times initial\ mass)=\frac{Mt\times Xts-Mo\times Xis}{Mo}\times 100$$

where, M_o is the initial mass (g) of fresh pumpkin sample. Mt is the mass (g) of the sample after pretreatment, X_{iw} is the initial moisture content of fresh pumpkin on a wet basis, X_{tw} is the moisture content of sample after pretreatment on a wet basis, X_{is} is the initial solid matter content of fresh pumpkin on a wet basis, X_{tw} is the solid matter content of sample after pretreatment on a wet basis.

2.3 Drying Process

Pretreated and fresh pumpkin cubes were subjected to hot air drying. Drying processes were continued until the moisture content of pumpkin slices fell below 10% (wb). Hot air drying was performed at 70°C in a Tray dryer. At the end of each drying experiment, the final moisture contents of samples were determined. The amount of dry matter for each sample was calculated by using the mean final moisture content and the weight of the dried sample and used for the determination of moisture contents during drying. Moisture content data obtained during drying was converted to moisture ratio (MR) values according to the following equation:

$$MR=\frac{Mt-Me}{Mo-Me}$$

Where, M_o is the initial moisture content, Me is the equilibrium moisture content, and M(t) is the moisture content at time t. The values of Me can be neglected since they are relatively small compared to M(t) and M_o [14].

2.4 Preparation of Pumpkin Powder

Each pumpkin untreated dried cubes, osmotically treated with 5, 10 and 15% salt solution pumpkin cubes were separately ground into fine powder using a household mixer grinder. The powder was then sieved using mess size (80-120) and the smooth powder obtained was then packed in separate polyethylene pouches and stored at room temperature till further analysis.

2.5 Proximate Analysis

The proximate analysis was done to obtain values for the moisture content, ash content, crude protein, crude fat, crude fiber and carbohydrate content in osmotically dehydrated dried pumpkin powder [13]. The moisture content was determined using an oven at 105 ± 1 °C to a constant weight and the ash content by incinerating in a muffle furnace at 500- 550ºC for 3-4 hrs until the residue was uniformly white or nearly white. Total lipids were determined by extraction in a Soxhlet apparatus using petroleum ether as solvent. Total protein was calculated from the nitrogen content measured by the Kjeldahl method using a factor 6.25, and calculated as N x 6.25. The content of crude fiber was determined according to the gravimetric procedure of [15]. Total carbohydrate was obtained by subtracting (crude protein + crude fat + ash + crude fiber+moisture) from 100. The moisture content was expressed in g/100 g sample and the other values were reported on a dry basis. All the analyses were performed in triplicate.

2.6 Physiochemical Properties

2.6.1 Vitamin C

Vitamin C was determined using a HPLC method (Hypersil ODS column (250 × 4.6 mm) of particle size 5 µm; mobile phase: HPLC grade water with metaphosphoric acid of pH 2.2; detection at 245 nm; calibrated by external standard solution of L-ascorbic acid [16]

2.6.1 pH

The pH value of pumpkin powder was determined following the [17] official method using the digital pH meter which was calibrated with distilled water, between pH 7 and pH 14.

2.6.1 Titratable acidity

Titratable acidity was determined according to [18] by titrating 50 ml of the homogenate samples against 0.1 N NaOH. First, the distilled water (1 L) used for titration was titrated with 0.1 N NaOH, and the volume of 0.1 N NaOH consumed by water titration was considered a blank. The volume of 0.1 N NaOH used for titration of the sample was noted and after correcting the blank, the percentage of citric acid is calculated[19] by using following formula:

$$\textit{Citric acid}(\%) = \frac{V \times 0.0064 \times 100}{W}$$

2.6.1 Total soluble solids

Determination of total soluble solid (TSS) was followed by the method described by [20] with some modification.1.00 g of pumpkin powder dissolve in 25ml distilled water. Then, the TSS was determined with the help of digital refract meter (HI96801) and was expressed as Brix (B) at room temperature. The measurement repeated three times and average values were taken.

2.6.1 Determination of β carotene

β-Carotene contents in pumpkin powder samples was determined by adopting the procedure illustrated by [21] . β-Carotene was determined using HPLC with UV/Visible photodiode.

2.6.1 Color

The color of control, pretreated, and dried pumpkin cubes was assessed using a handheld colorimeter (Lovibond LC-100 Spectrocolorimeter) with illuminant C and 2 degree observer and 8 mm aperture. The CIE L*a*b* color space was used for the determination of color parameters. The L*, a*, and b* values represent "lightness" with a range from 0 (black) to 100 (white), "redness" or "greenness" with a range from 260 (green) to 160 (red), and "yellowness" or "blueness" with a range from 260 (blue) to 160 (yellow), respectively. Three samples were tested to determine the mean L*, a*, and b* values, and for each one, three readings were taken at different a* b* color measurements.

2.7 Statistical analysis

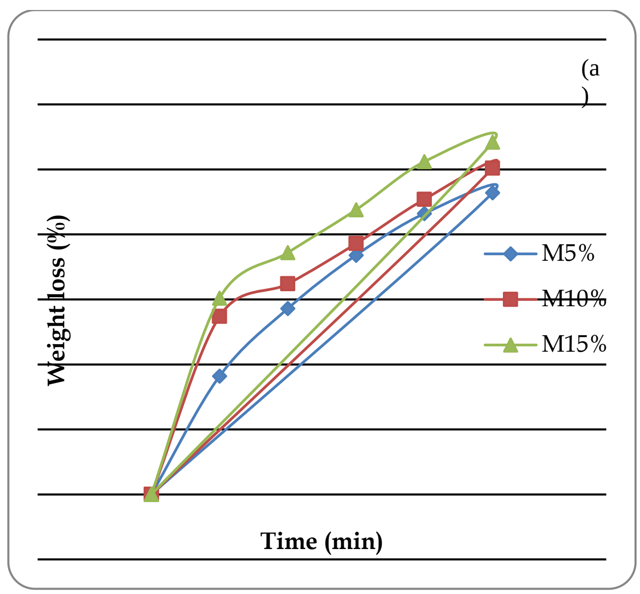
All drying experiments were conducted in triplicate and expressed in terms of mean and standard deviation.

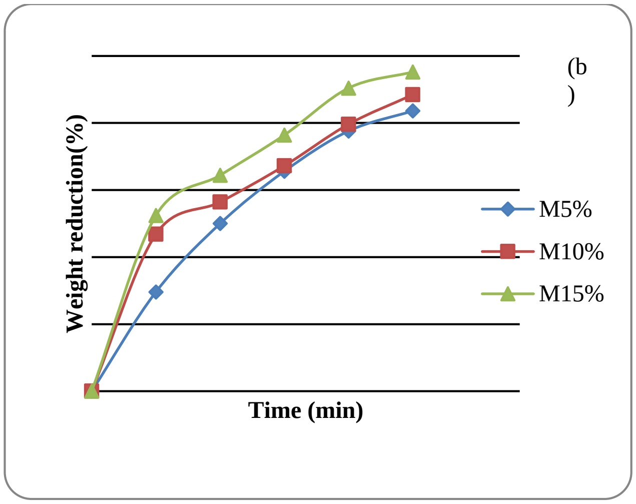
3. RESULT AND DISCUSSION

3.1 Effect of Osmotic Dehydration Pretreatment

Weight reduction (WR), water loss (WL), and solid gain (SG) of pumpkin slices subjected to osmotic dehydration pretreatments are presented in Figure 1. It is known that, these parameters were affected by factors such as type of product, type of osmotic agent, concentration of osmotic solution, dehydration time, and temperature during osmotic dehydration process [22-25]

It was found that concentration of osmotic solution, pretreatment time, and the concentration of osmotic solution × pretreatment time interaction are important factors affecting WR, WL, and SG of pumpkin slices. As expected, high salt concentration increased the WL values during assisted osmotic dehydration because of the greater osmotic gradient formed. According to the results shown optimum time (30min) was selected for the further pretreatments of osmotic dehydration and 15% concentration shows the best result when compared to Raw and other concentration level.





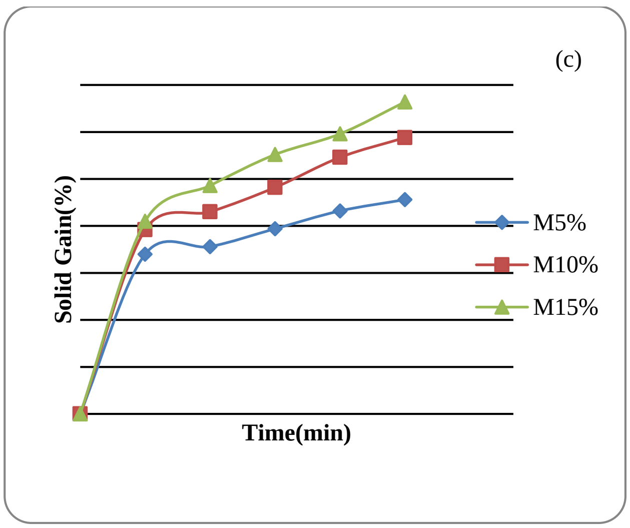


Figure 1: (a)Effects of OD on weight loss (WL), (b)solid gain (SG), and (c) weight reduction (WR) of pumpkin cubes.

3.2 Proximate analysis

As shown in Table1 there were significant differences among the treatments for moisture content. Control sample had the highest moisture content followed by 5%, 10% and 10% pumpkin powder, respectively. Prominently, moisture content decreases with the increase in the level of pumpkin powder, whereas the sample with 10% pumpkin powder recorded lowest moisture content (78.32%). Similar observation was reported by [26] who found significant decrease in moisture content of beef patties formulated with dried pumpkin pulp. In terms of the fat content, the results revealed that there was no significant difference among the treatments. It is noticeable, that fat content increased with the increase in the level of pumpkin powder, whereas the sample with 15% pumpkin powder recorded highest fat content (2.42%), while the sample of Raw pumpkin powder recorded lowest fat content (1.73 %).For the protein content, the 15% treatment had the highest protein content (4.32%) and the least value (1.58%) was reported for the raw. The differences of protein content among all treated samples could be attributed to the incorporated levels of dried pumpkin powder. Contrarily, [27] found that fish burger formulated with mashed pumpkin and mashed potato showed higher moisture and lower protein, fat and ash contents than control group. The ash content of (15%) treated samples was highest (3.45) among other treated samples when compared to raw (0.63%) however, there is significant increase in the ash content among all samples. The Fiber content of dried pumpkin powder in (15%) was higher (3.98%) among all treated samples and lowest in raw (1.78%). The Carbohydrate content also increases significantly in between (3.1% to 6.58%) when compared to raw and treated samples. Lowest value was observed in raw sample and highest value observed in (15%) treated sample.

Table 1: Proximate components of raw and osmotically treated Pumpkin flour.

Composition (%)	Raw sample	Osmotically treated samples		
		5%	10%	15%
Moisture	91.16±1.3	87.52±1.5	81.41±1.2	78.32±1.4
Protein	1.58±0.1	2.05±0.4	3.85±0.7	4.32±0.3
Fiber	1.78±0.1	2.13±0.3	3.43±0.5	3.98±0.2
Ash	0.63±1.2	1.67±1.4	2.79±1.4	3.45±1.5
Fat	1.73±0.2	1.94±0.5	2.18±0.3	2.42±0.7
Carbo-hydrates	3.1±1.3	4.75±1.4	5.43±1.3	6.58±1.5

3.3 Physiochemical analysis

From Table 2, it is shown that TSS of pumpkin powder was observed to increase with the concentration of the osmotic agent as the highest value was recorded in 15% solution (11.15 ° Brix) when compared to the raw (7.62). While, TA decreased with increasing concentration of the osmotic agent, from 3.09 to 1.14 in 0% to 15% salt concentration, respectively. This might be attributed to the fact that during osmosis solutes leach out from the pumpkin cubes into the solution. pH is the most important to assess the ability of a microorganism to grow in specific food and for its storage. The highest pH was observed in 15% salt solution (9.23), while lowest was observed in case of raw (6.52). Osmotically dehydrated treatment causes significant reduction in the level of vitamin C and carotenoid content , this is because carotenoid pigment and vitamin C are vulnerable to high temperature along with varying concentration of osmotic agent and thus get degraded. In case of vitamin C, no significant change was observed in 15% concentration, when compared with the raw, while in case of carotene content, there was a significant decrease in the fresh sample than in the treated ones.

Table 2. Physiochemical properties of Raw and Osmotically treated samples.

Samples	TSS (ºBrix)	Titratable acidity	pH	Vitamin C (mg/100g)	β-Carotene (mg/100g)
Raw	7.62±1.5	3.09±0.5	6.52±1.25	80.29±.75	2.35±0.005
5 %	9.20±1.2	2.05±1.5	7.81±1.21	78.52±1.45	2.21±0.005
10 %	10.25±1.0	1.82±1.7	8.53±1.11	75.13±2.54	2.15±0.003
15 %	11.15±1.3	1.14±2.5	9.23±2.13	73.54±2.68	2.08±0.002

3.4 Color

Optical properties such as color have a great impact on consumer acceptance of dried pumpkin product. The OD process changed significantly the color of the osmodehydrated pumpkins when compared to the pumpkin before osmotic dehydration (Table 3). The concentration of the osmotic agent had a pronounced effect on the final color of the osmodehydrated pumpkins. With the increase in concentration, there was a decrease in the lightness (L*) of the samples. The highest value was obtained for the samples osmodehydrated for raw, but a significant decrease of the L* parameter was obtained at 5, 10 and 15% concentration at 70℃. The redness of the samples decreased with increasing concentration, similar to the decrease in yellowness that was observed during osmotic pretreatment of pumpkin cubes.

Table 3. Color parameter of Raw and Osmotically treated pumpkin flour.

Color Parameter	Raw sample	Osmotically treated samples		
		5%	10%	15%
L	80.3±1.3	64.8±1.2	63.5±1.2	60.2±1.3
a	5.4±0.5	3.2±1.5	2.5±1.3	1.7±2.5
b	36.53±1.2	35.46±1.1	34.1±1.1	32.3±2.13

4. CONCLUSION

Osmotic dehydration is being a simple process, facilitates processing of tropical fruits and vegetables such as banana, sapota, pineapple, mango, guava, carrot, pumpkin, papaya etc. with retention of initial fruit characteristics viz., color, aroma and nutritional compounds. In preservation of fruits and vegetables osmotic dehydration process add value to the finished product, which is wholesome, nutritious and available throughout the year. In this study on osmotic dehydration of pumpkin cubes, treated at different concentrations of salt at 5, 10, 15% at room temperature for 30 min along with hot air drying at 70ºC temperature and different analysis was carried out and it can be concluded that the cubes which are treated with 15 % salt solution for 30 min. and hot air drying at 70ºC temperature shows the better results with significant changes in proximate and physiochemical characteristics.

REFERENCES

[1] Seshadri, V. S.,"Cucurbits", Indian Horticulture, 33, 1989, pp. 28-30.

[2] A.O.A.C, "Official Method for Vitamin C. Method No.920.87, *Association of Official Analytical Chemists, Washington, DC*, 2005.