Research Article

Effect of Different Pre-Treatments and Temperatures on Physicochemical Properties of Beetroot Chips

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Abstract

Beetroot is used as a raw material for the pharmaceutical, cosmetics, beverages, and the food industries. It decreases the risk of obesity and overall mortality, helpful in tumor reduction, heart disease, diabetes and promotes healthy hair, increase energy, and overall lower weight. Beetroot is a rich source of nutrients but has short shelf life. Dried beetroot has more keeping quality than the fresh one. This study explored the effect of different pretreatments potassium metabisulphite (KMS), blanching, blanching with KMS and control samples and different drying methods i.e. sun drying and tray drying (at temperatures 50°C, 60°C and 70°C) on the quality attributes of beetroot chips. Chips dried at 70°C temperature under tray drying were found to have lowest pH and moisture content and highest ash content. KMS plus blanching pretreated chips obtained the highest sensory scores. The present findings will offer more information in the selection of the best pretreatment and drying techniques for drying beetroot.

Keywords: Pharmaceutical, blanching, potassium metabisulphite (KMS), drying techniques

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Introduction

Beetroot (Beta vulgaris L.) is crop belonging to the Chenopodiaceae family having dark crimson color. It also gets referred to as beetroot, chard, spinach beetroot, sea beetroot, garden beetroot, white beetroot and Chukander [1]. This crop has a five to six month lifespan overall. Beets come in many different varieties, including Crimson globe, Egyptian early yellow, Sunset, Globe, Blood-red (long), etc. In addition to being used as food, beets are also used as a plant medicine and a food coloring. Other Beta vulgaris cultivars, particularly sugar beetroot, are used to produce a wide variety of beetroot products [2, 3].

Several highly bioactive phenolics found in beets, including rutin, epicatechin, and caffeic acid, are also recognised to be effective antioxidants [4-6]. It aids in the prevention of tumours, lowers the risk of diabetes, heart disease, obesity, and overall mortality, and encourages good hair, more energy, and overall weight loss. A number of beetroot root components have therapeutic benefits, including being diuretic, anti-cancer, anti-inflammatory, hepatoprotective, anti-hypertensive, anti-microbial, and anti-oxidant. In elderly persons, beetroot juice slows the advancement of dementia by increasing oxygenation to the brain [7-9].

Numerous dietary supplements and functional foods made from red beets are available in the market, including beetroot-enriched bread [10, 11], gels, fermented and fractionated juice, dried powder (tablets, capsules, and micro-capsulated formulations), juice and juice mixtures (mostly with lemon juice), and gels.

Due to their high perishability, seasonal availability, and abundance in a given area, vegetables present unique post-harvest processing challenges. Prices plunge sharply during peak season, forcing producers to sell at cheap prices. Glut leads to a significant decrease in market pricing and a severe decline in both the number and quality of vegetables. Only 1.8% of vegetables are thought to be produced for the food processing industry [12].

The drying process is crucial to the preservation of agricultural products [13]. The shelf life is extended, and water activity is decreased [14]. Post-harvest losses of fruits and vegetables account for 30–40% of the total crop [15]. In order to increase shelf life, minimise packaging costs, lower weights, improve appearance, preserve original flavour, and maintain nutritional content, a significant amount of food goods are dried in many different nations [16].

Pre-treatments for fruit and vegetables include washing with water, blanching, KMS, sugar, and salt, etc either alone or in combination, to suppress enzymatic browning and improve color, flavour, and texture retention before drying [17]. Pretreatment speeds up the drying process, likely as a result of the pretreated sample's softer and looser structure, which makes it easier to remove moisture during drying [18]. This study aims to find the physicochemical properties and sensory analysis of dried beetroot chips.

Materials and Methods

Raw Materials and Preparation of beetroot chips

Fresh beetroots were procured from local market in Meerut. Leaves and end portion of beetroots were removed with a knife, washed with tap water to remove the dust and dirt over the surface. It was peeled and again washed with tap water followed by slicing with chips cutter, the thickness of slices was kept 2 mm. Chips were then weighed and 500g samples were made for each pretreatment and methods of drying. Prepared dried chips were stored in LDPE pouches at room temperature.

Pretreatments

Prior to drying, three different pretreatments were carried out to the beetroot slices, and an untreated sample was used as a control in this study. The sliced beetroot was subjected to pre-treatments i.e. dipped in 0.5% potassium metabisulphite (KMS) for 20 minutes (T_1), hot water blanching for 3 minutes (T_2), blanching with 0.5 % potassium metabisulphite (KMS) for 3 minutes (T_3) and control (T_0). The slices were then removed from water and the surface moisture was removed by blotting paper.

Drying of Beetroot chips

Tray Drying

The tray drying was conducted at varying temperatures i.e. 50℃, 60℃ and 70℃. Once the temperature got maintained in the dryer, the slices (500 g each sample) were spread uniformly over the drying trays in a single layer and placed in the drying chamber. An electronic balance was used for weighing the samples. The drying process was continued till constant weight of the samples achieved. At the end of drying, samples were cooled at room temperature and stored for further studies.

Sun Drying

To carry out sun drying experiments, slices spread on black polyethylene sheets were kept under sun and loss of moisture was recorded at every 60 min for rest of drying period. Drying process was continued till constant weight of the sample attained. The dried product was then cooled to normal temperature and then packed.

Experimental Analysis

Physicochemical Properties

Physico-chemical properties of beetroot chips were determined at the time of 0 day and during storage of 30, 60 and 90 days. Moisture content of sample by standard air oven method and ash content was determined by [19] method. The samples of flours were mixed with equal quantity of distilled water and the pH was determined using digital pH meter after calibration with standard buffers of 4 and 7 [20].

Sensory Analysis

Sensory quality characteristics of fresh samples were evaluated by a panel of 10 untrained volunteer students in laboratories. The evaluation was done by using a 9-point Hedonic scale (1=extremely dislike, 9=extremely like). They were asked to score the internal characteristics of samples i.e. color, taste, texture and overall acceptability [21].

Results and Discussion

Moisture Content

The moisture content for different beetroot chips is presented in **Table 1**. The lowest moisture content value 4.0% was measured for KMS+Blanching chips under hot air tray drying at 70°C and highest moisture content value 8.7% was measured for untreated chips under hot air tray drying at 50°C at 0 day study. Moisture content was seen in increasing order based on temperature as 70°C, sun drying, 60°C and 50°C respectively. As analyzed according to pretreatments, it was minimum for KMS+Blanching treated chips and maximum for untreated chips. The study also showed that the moisture value was increased with increasing storage period. A food's moisture content has a significant impact on its nutrient density and shelf life. The dried beetroot chips' moisture content falls within the range that is considered acceptable for dried vegetables. Similar results were observed by [22] in which moisture content was found maximum for control and minimum for KMS treated dried broccoli.

Table 1 Effect of moisture content on dried beetroot chips having different temperatures and pretreatments during storage periods

Storage	Drying methods	Tray drying at 50°C	Tray drying at 60°C	Tray drying at 70°C	Sun drying
0 day	Control	8.7 ± 0.1	8.0 ± 0.2	4.7 ± 0.11	7.8 ± 0.057
	KMS	8.4 ± 0.057	7.2 ± 0.1	4.3 ± 0.2	6.6 ± 0.1
	Blanching	8.5 ± 0.1	7.6 ± 0.11	4.6 ± 0.057	7.1 ± 0.1
	KMS+Blanching	8.0 ± 0.1	7.0 ± 0.2	4.0 ± 0.057	6.9 ± 0.11
30 days	Control	9.5± 0.057	7.7 ± 0.1	4.7 ± 0.057	7.5 ± 0.2
	KMS	9.2 ± 0.057	7.5 ± 0.11	4.6 ± 0.2	7.3 ± 0.1
	Blanching	9.4 ± 0.1	8.2 ± 0.057	4.8 ± 0.057	7.9 ± 0.1
	KMS+Blanching	8.9 ± 0.2	7.3 ± 0.057	4.4± 0.1	7.1 ± 0.057
60 days	Control	9.6 ± 0.1	8.1 ± 0.11	5.5 ± 0.1	7.9 ± 0.2
	KMS	9.5 ± 0.11	7.7 ± 0.057	5.0 ± 0.1	7.6 ± 0.1
	Blanching	9.7 ± 0.057	8.5 ± 0.1	5.2 ± 0.057	8.3 ± 0.2
	KMS+Blanching	9.1 ± 0.1	7.4 ± 0.2	4.7 ± 0.11	7.3 ± 0.057
90 days	Control	9.8 ± 0.1	8.4 ± 0.057	5.8 ± 0.2	8.3 ± 0.1
	KMS	9.6 ± 0.1	7.9 ± 0.2	5.3 ± 0.057	7.7 ± 0.11
	Blanching	10 ± 0.11	8.8 ± 0.1	5.5 ± 0.1	8.6 ± 0.2
	KMS+Blanching	9.3 ± 0.2	7.7 ± 0.1	4.9 ± 0.2	7.6 ± 0.1

Ash Content

The ash content for different beetroot chips is presented in **Table 2**. The lowest ash content value 5.2% was measured for blanched chips under hot air tray drying at 60°C and highest ash content value 9.3% was measured for KMS treated chips under hot air tray drying at 70°C at 0 day study. It was seen in increasing order based on temperature as 60°C, sun drying, 50°C and 70°C respectively. As analyzed according to pretreatments, it was minimum for blanched chips and maximum for KMS treated chips. The study also showed that the ash value was decreased with increasing storage period.

Table 2 Effect of ash content on dried beetroot chips having different temperatures and pretreatments during storage periods

Storage	Drying methods	Tray drying at 50°C	Tray drying at 60°C	Tray drying at 70°C	Sun drying
0 day	Control	7.4 ± 0.1	7.3 ± 0.057	8.8 ± 0.2	7.7 ± 0.11
	KMS	8.0 ± 0.11	7.9 ± 0.1	9.3 ± 0.2	7.9 ± 0.057
	Blanching	5.7 ± 0.2	5.2 ± 0.1	6.0 ± 0.057	5.4 ± 0.2
	KMS+Blanching	6.9 ± 0.057	5.8 ± 0.11	7.1 ± 0.2	6.0 ± 0.057
30 days	Control	7.0 ± 0.11	7.0 ± 0.2	7.9 ± 0.11	7.2 ± 0.057
	KMS	7.6 ± 0.11	7.4 ± 0.057	8.0 ± 0.2	7.5 ± 0.1
	Blanching	5.0 ± 0.11	4.9 ± 0.057	5.4 ± 0.1	5.0 ± 0.11
	KMS+Blanching	6.4 ± 0.2	5.3 ± 0.11	6.5 ± 0.2	5.4 ± 0.057
60 days	Control	6.3 ± 0.11	6.3 ± 0.057	7.3 ± 0.2	6.7 ± 0.11
	KMS	7.4 ± 0.057	7.0 ± 0.2	8.9 ± 0.057	7.1 ± 0.1
	Blanching	4.5 ± 0.1	4.2 ± 0.057	4.8 ± 0.2	4.4 ± 0.11
	KMS+Blanching	5.8 ± 0.2	5.9 ± 0.057	6.0 ± 0.11	5.0 ± 0.057
90 days	Control	5.9± 0.1	6.0 ± 0.1	6.9 ± 0.2	6.1 ± 0.057
	KMS	7.0 ± 0.2	6.4 ± 0.057	7.6 ± 0.2	6.5 ± 0.11
	Blanching	4.1 ± 0.1	3.9 ± 0.2	4.3 ± 0.1	4.0 ± 0.1
	KMS+Blanching	5.2 ± 0.057	4.5 ± 0.11	5.4 ± 0.057	4.7 ± 0.2

pH

The pH for different beetroot chips is presented in **Table 3**. The lowest pH value 6.92 was measured for untreated chips under hot air tray drying at 70°C and highest pH value 7.69 was measured for KMS+Blanching chips under sun drying at 0 day study. It was seen in increasing order based on temperature as 70°C, 60°C, 50°C and sun drying, respectively. As analyzed according to pretreatments, it was minimum for untreated chips and maximum for KMS+Blanching chips. The study also showed that the pH value was increased with increasing storage period. Similar findings were observed by [23] in which increase in pH of KMS treated tomato powder was seen as compared to control sample.

Table 3 Effect of pH on dried beetroot chips having different temperatures and pretreatments during storage periods

Storage	Drying methods	Tray drying at 50°C	Tray drying at 60°C	Tray drying at 70°C	Sun drying
0 day	Control	7.24 ± 0.0585	7.10 ± 0.0152	6.92 ± 0.057	7.30 ± 0.0305
	KMS	7.37 ± 0.01	7.28 ± 0.057	7.00 ± 0.0264	7.45 ± 0.0152
	Blanching	7.50 ± 0.0152	7.39 ± 0.0585	7.19 ± 0.0152	7.58 ± 0.057
	KMS+Blanching	7.60 ± 0.0585	7.50 ± 0.057	7.37 ± 0.0152	7.69 ± 0.0585
30 days	Control	7.30 ± 0.0152	7.22 ± 0.01	7.00 ± 0.0585	7.42 ± 0.0173
	KMS	7.46 ± 0.057	7.35 ± 0.0585	7.09 ± 0.02	7.58 ± 0.0585
	Blanching	7.59 ± 0.0585	7.50 ± 0.0152	7.32 ± 0.057	7.69 ± 0.0305
	KMS+Blanching	7.68 ± 0.0585	7.59 ± 0.0173	7.49 ± 0.0152	7.78 ± 0.057
60 days	Control	7.62 ± 0.02	7.41 ± 0.0585	7.29 ± 0.0173	7.61 ± 0.0264
	KMS	7.70 ± 0.057	7.59 ± 0.02	7.40 ± 0.0152	7.76 ± 0.057
	Blanching	7.79 ± 0.0173	7.74 ± 0.0585	7.51 ± 0.0264	7.82 ± 0.0152
	KMS+Blanching	7.90 ± 0.0152	7.78 ± 0.057	7.68 ± 0.02	7.90 ± 0.057
90 days	Control	7.80 ± 0.0585	7.60 ± 0.0173	7.50 ± 0.0152	7.80 ± 0.0152
	KMS	7.93 ± 0.0152	7.79 ± 0.0152	7.65 ± 0.0264	7.99 ± 0.057
	Blanching	8.00 ± 0.057	7.90 ± 0.0305	7.70 ± 0.02	8.10 ± 0.0305
	KMS+Blanching	8.10 ± 0.0152	8.00 ± 0.0173	7.90 ± 0.0585	8.20 ± 0.01

Effect on Sensory Evaluation of Beetroot Chips

The sensory data for change in color, taste, texture and overall acceptability scores of beetroot chips is presented in **Tables 4-7**. Successful sensory estimate in food products is obtained by connecting nutrients and sensory properties to formulation which enables manufacturing food products with maximum consumer acceptance [24]. The sensory panelists reported that the sensory properties of the KMS+Blanching chips showed pleasant scores in all attributes. The highest scores were observed for KMS+Blanching chips under hot air tray drying at 60°C and the lowest for untreated chips under hot air tray drying at 70°C. The color, taste, texture and overall acceptability scores of KMS+Blanching chips were 7.55, 7.90, 7.77 and 7.50 respectively while lowest scores for control samples under tray drying at 70°C were observed as 6.55, 6.60, 6.29 and 6.00 respectively. There was noticeable decrement in all attributes with increasing the drying air temperature.

Table 4 Mean color score for dried beetroot chips

	Control	KMS	Blanching	KMS+ Blanching
Tray drying at 50°C	6.80 ± 0.527	7.00 ± 0.550	7.29 ± 0.506	7.42 ± 0.584
Tray drying at 60°C	6.90 ± 0.584	7.27 ± 0.550	7.39 ± 0.606	7.55 ± 0.665
Tray drying at 70°C	6.55 ± 0.665	6.75 ± 0.637	6.87 ± 0.506	7.18 ± 0.665
Sun drying	6.71 ± 0.637	6.99 ± 0.506	7.08 ± 0.637	7.35 ± 0.584

Table 5 Mean taste score for dried beetroot chips during storage periods

	Control	KMS	Blanching	KMS+ Blanching
Tray drying at 50°C	6.99 ± 0.527	7.21 ± 0.584	7.55 ± 0.665	7.71 ± 0.550
Tray drying at 60°C	7.20 ± 0.665	7.55 ± 0.506	7.71 ± 0.606	7.90 ± 0.527
Tray drying at 70°C	6.60 ± 0.584	6.90 ± 0.506	7.19 ± 0.584	7.33 ± 0.550
Sun drying	6.83 ± 0.550	7.01 ± 0.527	7.30 ± 0.506	7.50 ± 0.584

Table 6 Mean texture score for dried beetroot chips during storage periods

	Control	KMS	Blanching	KMS+ Blanching
Tray drying at 50°C	6.76 ± 0.629	6.96 ± 0.527	7.25 ± 0.550	7.50 ± 0.584
Tray drying at 60°C	7.10 ± 0.527	7.25 ± 0.764	7.31 ± 0.550	7.77 ± 0.665
Tray drying at 70°C	6.29 ± 0.629	6.31 ± 0.527	6.86 ± 0.629	7.01 ± 0.584
Sun drying	6.45 ± 0.764	6.57 ± 0.606	7.01 ± 0.861	7.22 ± 0.584

Table 7 Mean overall acceptability score for dried beetroot chips during storage periods

	Control	KMS	Blanching	KMS+Blanching
Tray drying at 50°C	6.49 ± 0.584	6.84 ± 0.676	7.10 ± 0.839	7.31 ± 0.676
Tray drying at 60°C	6.59 ± 0.676	6.95 ± 0.861	7.39 ± 0.598	7.50 ± 0.861
Tray drying at 70°C	6.00 ± 0.797	6.35 ± 0.807	6.70 ± 0.764	6.97 ± 0.676
Sun drying	6.23 ± 0.861	6.65 ± 0.797	6.87 ± 0.584	7.09 ± 0.807

Conclusion

Based on the outcomes of the current study, it can be established that the different pretreatment methods have a significant effect on the physical and chemical properties of beetroot. Results showed that higher temperatures lead to lower moisture retention in the products. It was also concluded that variation in temperatures and pretreatments also had effect on sensory properties. KMS+Blanching pretreatment with 60ºC temperature showed best sensorial attributes. The current results will provide a better understanding of different drying methods and also provide more information for choosing pretreatments for drying beetroot. Due to its low processing costs, quick processing, improved energy conservation, and higher retention of the dried product's physicochemical qualities, it is therefore perfect for usage on an industrial scale.

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Publication History

Received	30.07.2023
Revised	05.11.2023
Accepted	10.11.2023
Online	31.12.2023