Drying treatment: Effect on physico-chemical properties of dried broccoli

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Abstract

Broccoli is considered a highly nutritional vegetable. This study was carried out to dried broccoli florets were using a different temperature at 45, 55, and 65^0C. Parameters studied were moisture content (%), acidity content (%), chlorophyll content (mg/100gm), total polyphenols content (mg/100gm in terms of gallic acid), and vitamin c (mg/100gm).It was observed that there was no change in acidity, whereas there was loss of vitamin C content and slightly decreases in total phenolic content in terms of Gallic acid from hot air treatment. Also, chlorophyll retention was observed in hot air dried broccoli.

Keyword- Broccoli, nutritional compounds, conventional drying.

Introduction

Broccoli is a nutritious cool-weather cultivated crop and its consumption has increased due to its numerous health benefits. The broccoli stalk contains the nutritional value that can be used for product development. This vegetable consists of a swelled head which is clustered of green buds, and thick fleshy stalk. It is drawing increasingly wide attention owing to its health-promoting properties. Broccoli contains a high level of vitamins, especially vitamin C, bioactive compounds, including phenolics, chlorophyll, and dietary fiber. What deserves to notice is that the nutrient content may vary based on different storage period and dehydration or drying method.

Broccoli is accepted as a nutrient vegetable because it contains rich vitamins, minerals, and dietary fiber content but also in as much as the presence of bioactive compounds, like phenolics, glucosinolates, and sulforaphane, etc., which have been confirmed by researchers to be beneficial to human health. Consuming this vegetable improves the general health status, mainly due to its antioxidant properties [1]. Vegetables are the excellent sources of minerals and contribute to the recommended daily allowance (RDA) of these essential nutrients.

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Drying characteristics of broccoli stalk slices under hot air drying at temperatures of 45, 55 and 65 °C is presented. In addition, the color and shape changes of the dried sample were compared. Midilli et al. show a good agreement with the experimental data obtained for drying systems.

Various methods of drying have been developed for different purposes, and each of them has its own characteristics. Drying methods include convective air (cabinet, tunnel, fluidized bed, thin layer) dehydration methods. The most common and conventional way of broccoli drying is the hot air dehydration method with the benefit of low cost, easy operation, and convenience. Conventionally, hot air drying is used for drying food products due to its simple operation. However, hot air drying alone is a time-consuming process caused by the higher latent heat of vaporization requirement where heat has to diffuse in from the surface of the material.

Jin et al.[6]reported a dynamic optimization strategy to determine the best moisture-temperature trajectories that maximize retention of glucosinolates and vitamin C in broccoli stalks with minimum energy consumption in convective drying.Mrkic et al. [10] investigated the effect of temperature (50–100 °C) and air flow rate (1.20–2.25 ms^{-1}) in a pilot tray dryer on the content of bioactive compounds and antioxidant activity of broccoli.

The aim of this work was too functional aspects of the main bioactive compounds, vitamin c, chlorophyll content, total polyphenolic compounds, moisture and acidity found in broccoli and to discuss the effects of processing conditions on the health-promoting properties of this vegetable. To estimate effective content of moisture (%), acidity (%), chlorophyll content (mg/100gm), total polyphenolic content (mg/100gm in terms of gallic acid) and vitamin c (mg/100gm) was studied under different operating temperature (45^0c, 45^0c, and 55^0c).

Materials and methods

2.1 Sample Preparation:

The experimental material was a fresh broccoli (Brassica oleracea L.), purchased in a retail market store in Nagpur in 2018. Fresh broccoli heads were used per experimental replication. The average weight of a broccoli head was 4-6 g. Broccoli was cleaned and separated into florets with stems to produce samples. The following blanching processing is 101°C for 2 min parameters were applied. Blanching samples for microwave drying analyses were cooled to room temperature (25 ± 2°C).

2.2 Drying

Drying experiments were performed in a laboratory tray dryer. The pre-processed sample was blanched at 99 ± 1 ^{0}c for 2 min. Petri plates were used to take broccoli samples for analysis

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purposes. Samples (5-8 g) were taken out every 5 min first five Petri plates, second five Petri plates were taken out every 10 min and last plates were taken out every 15 min and also taken out until moisture content constant. Drying experiments were conducted at 45, 55 and 65^0C, with constant air flow rate equal and relative air humidity in the range of 40-60%, until the sample reached constant moisture content. The temperature of the sample was measured using a digital thermometerin tray dryer already fixed.

2.3 Physiochemical Analysis

Physiochemical Analysis of each batch includes moisture, total acidity measurement, vitamin C, chlorophyll content and total phenolic content. All readings are in triplicates.

2.3.1 Moisture content:

The moisture content of all the samples was determined according to standard methods of AOAC. The sample (5 gm) of a sample was oven dried at 110^0C and moisture content of the sample was calculated.

2.3.2. Total Acidity:

Total acidity was determined by the procedure stated in Ranganna [12]. Standardization of NaOH (0.1N) was done by using aliquot (10ml) of oxalic acid (0.1N) and phenolphthalein as an indicator. Dried broccoli was crushed in a mortar and homogenize with sterile distilled water. The extract was filtered using Whatman filter paper no. 1. Further volume was made up to 100 ml with distilled water. The aliquot (5 ml) was titrated with (0.1N) NaOH. Persistence of pink color for at least 15 sec indicates the completion of titration. Each determination was in triplicate.

2.3.3. Ascorbic Acid (Vitamin C):

Ascorbic acid of the dried broccoli was determined by 2, 6-Dichlorophenol-Indophenol visual titration method [7] with modifications. Standard ascorbic acid ($0.1mgml^{-1}$) was standardized by 2, 6-Dichlorophenol-Indophenol. Dried broccoli was crushed in a mortar and homogenize with HPO_3.The extract was filtered using Whatman filter paper no. 1. Further volume was made up to 100 ml with HPO_3. The aliquot was titrated with 2, 6-Dichlorophenol-Indophenol. The endpoint was noted when pink color was persist at least 15 sec. All measure was in triplicate.

2.3.4. Total Chlorophyll content:

The total chl content of the dried broccoli was determined by using method describe by Rangnna [12]. Dried broccoli (3-5 gm) was crushed in a mortar and homogenize with 80% acetone (21ml). Transfer to centrifugation tube for centrifugation process and centrifuge 1000-1200 rpm (15 min) at $4\ ^0$c conditions. Further filter on a Whatman filter paper no. 1 used. Filter the extract to a 250 ml volumetric flask, wash the filter paper and makeup to mark with acetone. Take 50 ml of ether in a separating funnel, pipette 30-35 ml of extract sample (acetone extract) into a separating funnel. Few amount or ml of water added from the side of separating funnel until the water layer is apparently free of all the fat-soluble pigments. drain out the water layer. Transfer the ether extract to 100 ml volumetric flask, dilute to volume with ether and proper mix. And add 3-5 gm of anhydrous Na_2SO_4. Wait till the solution become clear. For spectrophotometric

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(Labman Scientific Instrument) measurement, in one take ether as blank, and in the other take the diluted ether extract of chlorophyll. Take readings between 658-655 nm. Note the readings at 660 nm and 642.5 nm for UV visible spectrophotometric (Labman Scientific Instrument) measurement. Each determination was in triplicate.

2.3.5.Total Phenolic Content:

The total phenolic content of the sample was calculated by using FolinCiocalteu's method described in Chuah et al. [2]with some modifications. Dried broccoli (3gm) was crushed in a mortar with 80% methanol and then the sample was stored for 2 hours under control refrigeration conditions (at 4^0C). Then the sample was centrifuged at 3000 rpm for 20 min and filter on a Whatman filter paper no. 1. The clean extract was stored at 4^0C for further analysis.

0.4 ml of dried broccoli extract and gallic acid (GA) (20, 40, 60 and 80µl) solution was transferred to the test tube; 5ml water was added. Followed by this 0.5 ml FolinCiocalteu's (FC) (10 fold) reagent was added. After 3 min 20% Na_2CO_3 was added to make up the volume 10ml and shaken. The sample was then put into the water bath (100^0C) for 1min. After cooling at room temperature absorbance was measured on UV visible spectrophotometer (Labman Scientific Instrument) at 640 nm. Gallic acid (GA) calibration curve was plotted to compare the spectrophotometric absorbance. Results were expressed as mg GA $100g^{-1}$ osmotically dehydrated plum. All measures were done in triplicates.

2.4 Statistical analysis:

An analysis of variance (ANOVA) with which are factors in broccoli present (moisture content, acidity, ascorbic acid content, chlorophyll content, total polyphenolic content (in terms gallic acid), and rehydration) was performed on each quality parameter, using GraphPad Prism 5.00.288 applying an analysis of variance (ANOVA). Least Significant Differences (LSD) test was used for testing significant differences between means with a confidence level of 95%. In addition, the Bonferroni test included in the statistical program was used to compare the entire column with each other.

Results

Following figure present the mean values and standard deviation of the moisture content (%), acidity (%), vitamin C (mg/100gm), total Chlorophyll content (mg/100gm) and total phenolic content (mg GA/100gm) of blanch sample of broccoli by using different hot air treatments temperature (45, 55 and 65^0C) with respect to different level operating parameters $p<0.05$ and (confidence level 95%)

1) Moisture:

Figure no. 1 present the moisture content of dried broccoli by using cabinet dryer at different temperature (45^0C, 50^0C, and 55^0C). From the figure, it was observed that there is no significant change in moisture content of broccoli at a different drying temperature of cabinet dryer.Similar results for moisture content also reported [4].

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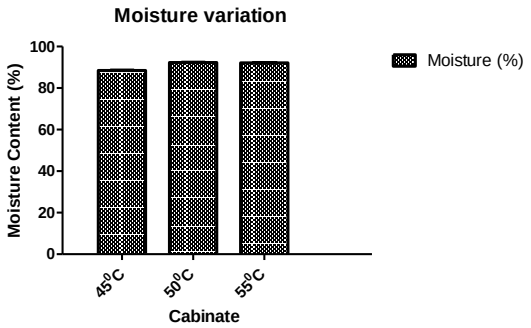

Figure no. 1: Changes in Moisture Content of dried Broccoli at different temperature using cabinet dryer. Combined Bars represent a mean ± standard deviation of triplicates (n=3).

2) Acidity (%)

Figure no. 2 present the variation in acidity content of dried broccoli at different temperature (45^0C, 50^0C, and 55^0C) by using cabinet dryer in the form of combined bar graph. From the figure, it was observed that there is no significant change in acidity content of dried broccoli.

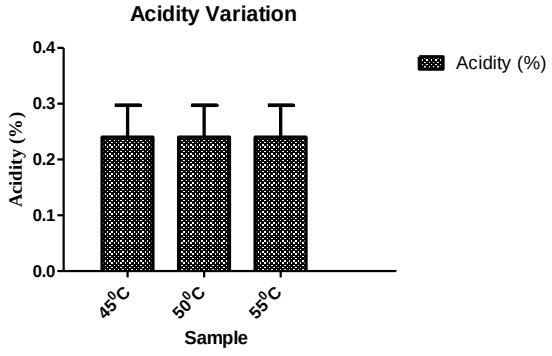

Figure no. 2: Changes in acidity Content of dried Broccoli at different temperature using cabinet dryer. Combined Bars represent a mean ± standard deviation of triplicates (n=3).

3) Vitamin C

Figure no. 3 present the combined bar graph of changes in vitamin C content of dried broccoli at a different temperature. From the figure, it was observed that there is a significant decrease in vitamin C content of dried broccoli with increasing processing temperature. Broccoli sample dried at 45^0C gives better results of vitamin C retention than other two temperatures.

Ascorbic acid concentration decreases with processing temperature and hypertonic solution concentration [3]. Vitamin C is highly heated sensitive, is easily destroyed during processing. However, some enzymes like cytochrome oxidase, ascorbic acid oxidase and peroxidase found in fruits also responsible for ascorbic acid degradation [13] and Karim, O.R. for peach [8].

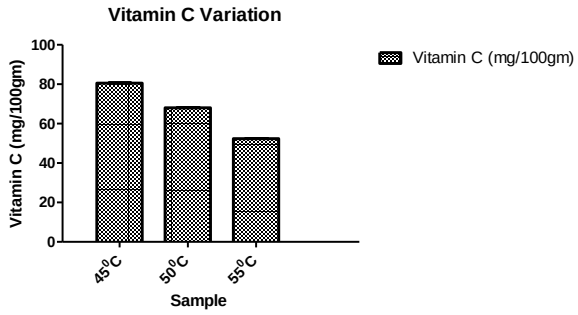

Figure no. 3: Changes in Vitamin C Content of dried Broccoli at different temperature using cabinet dryer.

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Combined Bars represent a mean ± standard deviation of triplicates (n=3).

4) Total Phenolic Content

Figure no. 4 present the total phenolic content during cabinet drying of broccoli at different temperature (45^0C, 50^0C, and 55^0C). From the combined graph it was observed that the total phenolic content of broccoli was significantly decreasing with increasing processing temperature. The sample process at 45^0C gives better retention of vitamin c than other two processing temperature.

Various factors are responsible for TPC change like temperature, pH, enzymes, organic acids and many more. Polyphenol oxidase and other enzymes are responsible for TPC degradation during drying but higher processing temperature and longer exposure results into inactivation of these enzymes. Que and et al. [11] reported that formation of phenolic compounds occur during drying because precursor of phenolic compounds present in the fruits is converted into phenolic compounds with the help of non-enzymatic interconversion. Besides, this some researchers were reported phenolic compounds are decreased during thermal processing of food products and some were reported there is no significant change in the TPC. TPC content of dried pears decreased significantly with increase in temperature.

Phenolic content of osmotically (NaCl as a hypertonic solution) pretreated grapes was increased on drying was reported by, J. Carranza-Concha and et al. [5]. This might be due to structural changes in drying and skin damage due to pretreatment.

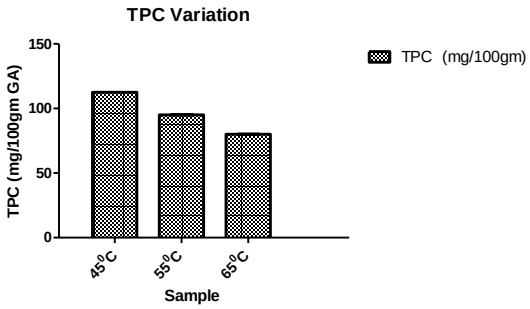

Figure no. 4: Changes in the Total phenolic content of dried Broccoli at different temperature using cabinet dryer. Combined Bars represent a mean ± standard deviation of triplicates (n=3).

5) Chlorophyll content:

Changes in total chlorophyll (Chlorophyll a, Chlorophyll b and total chlorophyll) content during drying of broccoli at different temperature were presented in figure no. 5. From the figure it was observed that chlorophyll a decreases significantly with increasing the temperature of processing, chlorophyll b is not that much affected and total chlorophyll content also decreases significantly with increasing processing temperature.The evolution of the content of total chlorophyll was slightly different to that observed in superficial color. Control florets showed a continuous degradation of chlorophyll, reaching a loss of approximately 50% after 3 weeks at 0 ^{0}C [9].

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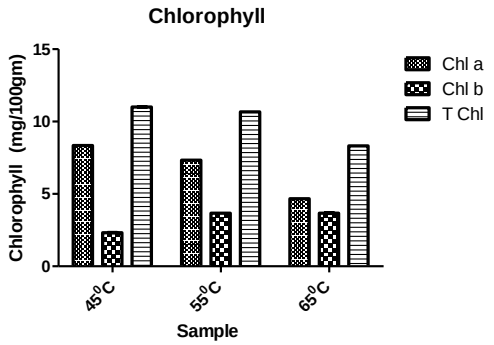

Figure no. 5: Changes in total chlorophyll content of dried Broccoli at different temperature using cabinet dryer. Combined Bars represent a mean ± standard deviation of triplicates (n=3).

Conclusion

In this study, the effect of cabinet drying temperature in the range of 45, 55, and 65 ^{0}C on physicochemical properties of dried broccoli was studied. Cabinet drying temperature, drying time and moisture removal also had significant effects on color and nutrients contents (total phenolic and ascorbic acid contents and chlorophyll).The highest drying temperatures resulted in the greater change in nutrients contents.

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