International Journal of
Innovative Research

International Journal of Innovative Research, **8(1)**: 12–19, 2023
ISSN 2520-5919 (online)
www.irsbd.org

RESEARCH PAPER

Effect of Conventional Storage Techniques on Physico-chemical Properties of Dehydrated Cauliflower

Mousume Ahmed[1], Md. Roman Akon[1*], Md. Fakhrul Hasan[2], Jewel Howlader[1], Mahmuda Nipa[1]

[1]**Department of Horticulture, Patuakhali Science and Technology University, Dumki, Patuakhali-8602, Bangladesh.**
[2]**Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur-1706, Bangladesh.**

ARTICLE HISTORY

Received: January 03, 2023
Revised : February 18, 2023
Accepted: March 24, 2023
Published: April 30, 2023

*Corresponding author:
mrakon.hort@pstu.ac.bd

ABSTRACT

An experiment was conducted at the Postharvest Laboratory, Department of Horticulture, Patuakhali Science and Technology University, to evaluate the nutritional quality of dried cauliflower under different storage conditions. The single factor experiment consisted of four treatments; storage of dehydrated cauliflower in a glass jar (T_1), plastic jar (T_2), polythene bag (T_3), and open petridish (T_4). Where the storage of dehydrated cauliflower in petridish in the open air was considered as control. The experiment was laid out in a Completely Randomized Design with three replications. Cauliflower florets were separated and sliced with the help of a stainless steel knife in a thickness of about 3 mm. Sliced cauliflower was blanched for 30 seconds and then kept in the aluminum tray for drying in the oven for 12 hours at 60 ºC temperature. Results showed that quality traits were changed significantly during 3 months of storage. Proximate analysis showed that significantly the lowest amount of moisture content (0.00%), titratable acidity (0.3%) and fungal growth and the highest amount of anthocyanin content (12.55 µg/g), pH value (5.83), and total phenol content (0.73 mg/100g) were found in dehydrated cauliflower stored in a glass jar (T_1). On the other hand, moisture content (3.66%), titratable acidity (1.20%), carbohydrate content (16.0g/100g), and fungal growth were significantly the highest in treatment T_4 (open petridish storage) where the amount of total phenol content (0.07 mg/100g), antioxidant content (0.008 µg/g)), pH value (4.83), total soluble solid content (6.5%), and anthocyanin content (1.22 µg/g) were significantly the lowest in the dehydrated cauliflower stored in open petridish (T_1). The growth of the microbial colony (*Escherichia coli*) was not found in dried cauliflower after 3 months of storage. Fungal growth was found in T_4 (open petridish) after 3 months of storage. During the storage of dehydrated cauliflower, the performance of treatment T_1 (storage of cauliflower in a glass jar) was the best regarding moisture content, titratable acidity, fungal growth, anthocyanin content, pH value, and total phenol content.

Key words: Cauliflower, Processed quality, Shelf life, Storage Condition, Storage quality

Introduction

Vegetables are an important source of nutrients that are extremely advantageous for health. Consumption of vegetables is highly exhilarated in several countries of the world to prevent numerous diseases such as cancer and cardiovascular disorders (Steinmetz & Potter 1996). Cauliflower (*Brassica oleracea*, var. botrytis) is a relatively abundant source of antioxidants, containing on an average 161.06 µmol of glucosinolates/100g fresh weight that have potential anti-carcinogenic activity (Delonga *et al.* 2007). In Bangladesh, cauliflower is an important Cole crop (crop near to the soil). It is well known for its curd color, texture, and quality and has great potential in the domestic and export markets. Cauliflower is used as fresh or cooked vegetable; sometimes as an ingredient in pickles (Steinmetz & Potter 1996). In almost all parts of Bangladesh, it is cultivated in the winter season. The total area under cauliflower cultivation in Bangladesh is about 9400 hectares and the amount of annual production is about 307000 metric tons (Yearbook 2020).

Cauliflowers are grown as seasonal (winter) vegetables in Bangladesh. Due to its high nutritional value demand is not season specific. On the other hand, it is highly perishable in nature. Cauliflower is usually stored for only a short period as needed for orderly marketing. At room temperature (20–25 °C), it turns yellow within 2 days after harvest under ambient atmospheres. Without processing, the year-round availability of cauliflower is very difficult. So, storage of processed products can be an alternate way to extend the shelf life. Dehydrated cauliflower can be used to enhance the taste and nutritional value of various products such as rehydrated vegetable mix, soup, canned products, extruded products etc. The selection of proper drying and storage condition is of prime importance for reducing thermal stress and retaining the key compounds in the rehydrated product. Several scientists (Jadhav *et al.* 2005; Kadam & Samuel 2006) have reported the drying mechanism of cauliflower, but optimum storage conditions are required to be accessed as per desired characteristics in the dehydrated product.

Though cauliflower is grown profusely in Bangladesh, it is gaining popularity among the vegetable growers but due to its highly perishable nature, the shelf life of the crop is very short. Even though the crop is very nutritious and costly, there is a lack of research and technical information regarding the traditional storage techniques of the crop. So, the current research work was conducted to extend the shelf life of cauliflower using traditional storage techniques to see the changes during storage at room temperature. Careful monitoring was done to select the best storage technique among the various traditional storage techniques being used in the current research work.

Materials and Methods

The single factor experiment was laid out in the Completely Randomized Design (CRD) with three replications. The collected data on various parameters were statistically analyzed using Minitab Statistical software version 17 (Minitab lnc. State College, PA, USA); and the means were separated using Tukey at 5% level of probability.

Fresh cauliflowers of snowball variety (mid-season) were procured from the "Vegetable Museum" of the Department of Horticulture, Patuakhali Science and Technology University, Bangladesh. The cauliflower was washed and cleaned with water to remove dirt, dust, etc. Then it was surface dried on filter paper for draining the water. Each whole cauliflower was cut with stainless steel knife and florets (edible portion) were kept for the study where the non-edible portion comprising of the upper stem, stalks, and leaf midribs were discarded. Then the cauliflower florets were separated and sliced with the help of a stainless steel knife in a thickness of about 3 mm (Plate 1). Sliced cauliflower florets were kept in a saucepan and boiled for 30 seconds for blanching. The blanched samples were cooled immediately by keeping them under running tap water at ambient conditions to prevent overcooking of the samples. Then the blanched cauliflower was kept in the aluminum tray for drying in the oven for 12 hours at 60 ºC temperature.

After blanching the glass jar, plastic jar, polythene bag and petridish were used to preserve and analyze the quality of the dehydrated cauliflower (Plate 2). All the samples were kept at room temperature for 3 months of storage period and evaluated for quality characteristics.

Plate 1: Processing of cauliflower for dehydration (A): slices of cauliflower (B): blanching of cauliflower (C): cooling of blanched samples.

The color, moisture content, firmness, and other qualities were evaluated at 15 days intervals.

Plate 2: Storage techniques of dehydrated cauliflower (A): storage in glass jar (B): storage in plastic jar (C): storage in poly bag (D): storage in open petridish (control).

Folin-Ciocalteau reagents, Gallic acid, Rutin Hydrate, TPTZ, ferric chloride, sodium hydroxide, and methanol were purchased from Merck, Germany. 2, 2-diphenyl-1-picrylhydrazyl (DPPH) was purchased from Sigma Aldrich Co. Ascorbic acid and NBT were purchased from BDH Co. and ferrozine from Loba India. All the chemicals and reagents were of analytical grade.

The moisture content of dehydrated cauliflower was determined by an electrical oven at 60 ºC for 12 hrs. After cooling, the sample was weighed carefully with an electronic balance (BP 2100, Sartorius, Germany). The percentage of moisture content was calculated by using the following formula:

$$\text{Moisture content (\%)} = \frac{loss\ in\ weight}{Weight\ of\ sample} \times 100$$

The color of the dehydrated cauliflower was determined by using an android application Software "On Color Measure'' (developed by Potato tree Soft Version 3.0) equipped with an aim point. The color was expressed in chromaticity values of Red (R*), Green (G*), and Blue (B*). Filtrated juice of the cauliflower sample was used to measure the p^H of the dehydrated cauliflower. The p^H was determined by using a glass electrode p^H meter (GLP 21, Crison, Barcelona, and EEC). The titratable acidity of dehydrated cauliflower was determined by the method of Ranganna (1979) and was expressed in percentage (%). The total soluble solids (TSS) concentration of the dehydrated cauliflower tissue was determined using a digital refractometer (Model N-1 α, Atago, Japan) and was expressed in percentage. The total anthocyanin content of dehydrated cauliflower was determined as per the method of Sims and Gamon (2002) and was expressed in µg/g. The amount of total phenolic content was determined following the established method described by Chanda and Dave (2009) with some modifications and was expressed in milligrams (mg) per 100 grams. Determination of total antioxidant activity was done as per the phosphomolybdenum method of Alakh *et al.* (2011) with some modification and was expressed in milligrams of the equivalent of Gallic acid. Total soluble carbohydrates were estimated by phenol, sulphuric acid method DuBois *et al.* (1956) and were expressed in grams per 100 grams.

The microbial profile (*E. coli* and fungal growth) of dried cauliflower during storage was studied. Five grams (5 g) of dehydrated cauliflower from each treatment was taken and soaked in 20 ml of sterilized water. Then it was shaken at 100 rpm for 24 hours at room temperature (28 ± 2^0 C). Fold serial dilution (10^{-1}–10^{-6}) of the suspension was made in the tubes. Then fold serial dilutions (10^{-1}–10^{-5}) of the suspension were made in test tubes. After that, 100 µl suspensions from each test tube were spread on VRBA (Violet Red Bile Agar) medium by a sterile bend glass rod and incubated for 96 hours at 28 ± 2^0 C. After 4 days (96 hours) of incubation suspensions were observed for *E. coli* colony formation (Plate 3). Dried samples of cauliflower were also observed to test fungal growth during storage.

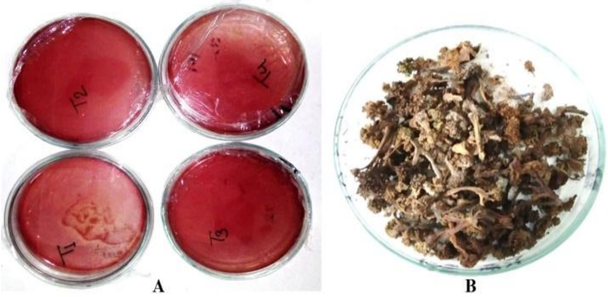

Plate 3: Dehydrated cauliflower suspension spread on VRBA medium; colony of *E. coli* was not found on VRBA medium (A). Fungal growth was observed after 90 days of storage in open petridish in cauliflower (B).

Results and Discussion

Moisture content (%)

Dehydrated cauliflower under all the treatments showed a decreasing trend of moisture content after 90 days of storage (DAS) (Table 1). The observed increase in moisture content in T_1, T_2 and T_3 at 30, 45 and 60 DAS respectively could be interpreted as being a result of changes in the atmospheric condition of the storage area. Dry vegetables contain relatively less moisture and are safely stored for a long period at ambient temperature without a reduction in quality (Ramaswamy & Marcotte 2006).

Table 1. Effect of storage on moisture content (%) of dehydrated cauliflower

Treatments	Moisture Content (%)					
	15 DAS	**30 DAS**	**45 DAS**	**60 DAS**	**75 DAS**	**90 DAS**
T_1	0.00^{b}	0.00^{c}	2.66^{b}	3.00^{bc}	0.00^{d}	0.00^{b}
T_2	0.66^{b}	2.66^{bc}	4.00^{ab}	4.66^{ab}	0.00^{c}	0.03^{b}
T_3	1.00^{b}	4.66^{b}	5.66^{a}	5.66^{a}	0.00^{b}	0.66^{b}
T_4	8.33^{a}	8.33^{a}	3.00^{b}	1.00^{c}	1.00^{a}	3.66^{a}
LSD at 5%	3.13	2.94	1.87	1.60	1.09	0.99
Level of significant	*	*	*	*	*	*
CV (%)	1.18	1.05	1.18	1.21	1.19	1.01

In the column, values having a similar letter(s) are statistically identical and those having the dissimilar letter(s) differ significantly at 5% level of probability analyzed by Tukey. T_1= glass jar storage, T_2= plastic jar storage, T_3= polythene bag storage and T_4= open petridish storage. DAS= Days after storage; *= Significant at 5% level of probability; CV= Co-efficient of variation.

Color

Color is one of the most important criteria that revealed the quality of dehydrated cauliflower. Color changes in the dehydrated cauliflower were observed by measuring the value of Red (R), Green (G), and Blue (B) percentages. The highest score of RGB% (59.0) was observed in T_2 and the lowest (44.5) was found in T_4 after 90 days of storage (Fig. 1). The blanching process favored the retention of dehydrated cauliflower color but samples treated with open petridish were seen to decrease in color (darker) with the increase in the storage period. Blanching improves the color of products by preventing discoloration and improving brightness, thereby making the product more attractive for consumption (Kilara *et al.* 1984; Brewer *et al.* 1995). Atmospheric air leads to senescence and loss of green color. Hence, the natural biological variance and the packaging technology used lead to different respiration rates and thus color changes in a packaged wild rocket (Martinez-Sanchez *et al.* 2008; Seefeldt *et al.* 2012). During postharvest senescence, the green chlorophyll pigments are oxidized into color-less substances revealing the yellow carotenoids (Toivonen & Brummell 2008). Discoloration may be due to the action of enzymes or caramelization-type reactions (Ur-Rehman & Awan 2012).

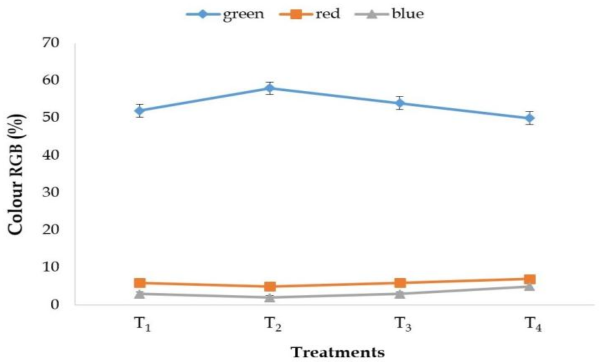

Figure 1: RGB% of dehydrated Cauliflower at different treatments. T_1=glass jar storage, T_2=plastic jar storage, T_3= polythene bag storage and T_4= open petridish storage.

p^H value

During the storage period, the changes in the p^H value of the dehydrated cauliflower were observed. The p^H value was decreased gradually with the increase in storage period under all treatments (Table 2). During sample preparation, the value of p^H was 6.70. After 90 days of storage, the highest p^H value (5.83) was observed in T_1 (dehydrated cauliflower stored in glass jar). However, the p^H levels of the dehydrated samples indicated that they were acidic in nature (Akubor & Ogbadu 2003). The decreased p^H was due to the increase in acidity of the samples. Dehydrated cauliflowers have moderate p^H levels because they are rich in organic acids (Mgaya-Kilima *et al.* 2014). It is also possible to have less biochemical reaction taking place during storage periods together with microbial action in the samples (Moses *et al.* 2013).

Table 2. Effects of storage on p^H of dehydrated cauliflower

Treatments	p^H					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T_1	6.38^a	6.55^a	6.16^a	5.99^b	5.90^a	5.83^a
T_2	6.35^a	6.34^a	6.17^a	6.12^b	6.12^a	5.79^a
T_3	6.04^a	6.15^a	6.56^a	6.28^a	6.06^a	5.75^a
T_4	6.66^a	6.67^a	6.32^a	5.29^c	5.03^b	4.83^b
LSD at 5%	0.94	0.93	0.77	0.62	0.34	0.31
Level of significant	NS	NS	NS	*	*	*
CV (%)	5.30	5.13	3.68	4.69	4.01	3.80

In the column, values having a similar letter(s) are statistically identical and those having the dissimilar letter(s) differ significantly at 5% level of probability analyzed by Tukey. T_1= glass jar storage, T_2= plastic jar storage, T_3= polythene bag storage and T_4= open petridish storage. DAS= Days after storage; *= Significant at 5% level of probability; NS= Non-significant; CV= Co-efficient of variation.

Titratable acidity (TA)

The titratable acidity values of dehydrated cauliflower decreased with the increase of the storage period (Fig. 2). Significant variation of titratable acidity was observed in all treatments. After 90 days of storage, the highest (1.35%) value of titratable acidity was found in dehydrated cauliflower stored in open petridish (T_4) and the lowest (0.4%) was in T_1 (storage of dehydrated cauliflower in glass jar).

Titratable acidity of vegetables decreased continuously during storage (Upadhyay *et al.* 1994; Erkan *et al.* 2004). Acidity was reduced during storage because of the growth on the attainment of maturity and ripening. This relationship suggests the possibility of an intimate balance between the active acidity and the carbohydrate reserves.

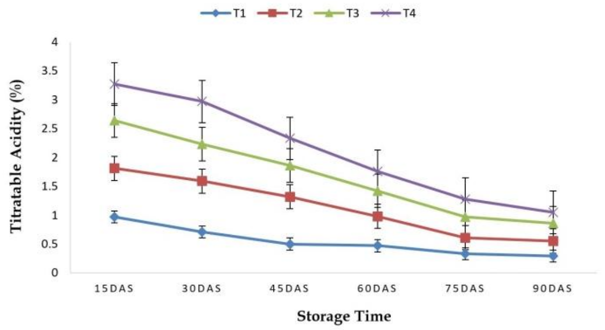

Figure 2: Relationship between titratable acidity and storage duration of dehydrated cauliflower. Vertical bars represent standard error. T_1= glass jar storage, T_2= plastic jar storage, T_3= polythene bag storage and T_4= open petridish storage.

Total soluble solid (TSS)

The effect of different treatments on the total soluble solid content of cauliflower during the storage period was significant (Fig. 3). A decreasing trend in TSS was recorded for every 15 days of observation. Maximum TSS (7.65 %) was recorded in cauliflower stored in the plastic jar (T_2) after 90 days while the minimum value of TSS (6.5 %) was observed in treatment T_1 after 90 days of storage. A decrease of brix value was observed during storage of broccoli as reported by Piñeros-Castro *et al.* (2011). The decreasing trend in TSS may be explained by the finding of Li and Gao (2000) who showed that the senescence of packed broccoli stored at 16 ºC was very fast; the content of total soluble protein, total acids, vitamin C, and chlorophyll decreased rapidly.

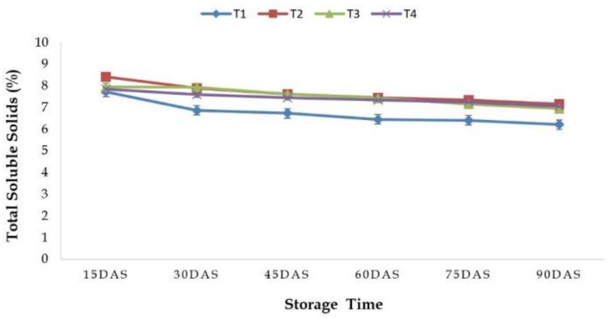

Figure 3: Relationship between total soluble solid (TSS) (%) and storage duration of dehydrated cauliflower. Vertical bar represents standard error. T_1= glass jar storage, T_2= plastic jar storage, T_3= polythene bag storage and T_4= open petridish storage.

Total anthocyanin content (µg/g)

Anthocyanin is well known because of its antioxidant properties and its pigmenting power that makes them attractive to be used (Ajila *et al.* 2007). During storage, the highest (18.62 µg/g) value of anthocyanin content was found in treatment T_2 (plastic jar) at 15 DAS. Anthocyanin content was significantly decreased in dehydrated cauliflower during storage (Table 3). Ninety days after storage, anthocyanin content was the highest (12.55 µg/g) in T_1 and the lowest (1.22 µg/g) was found in T_4. The color of fruits and vegetables are altered as a result of drying. Carotenoids are mostly changed during drying. Anthocyanins are also destroyed by drying treatments. The natural green pigment of vegetables is a mixture of chlorophyll a and chlorophyll b. The retention of the natural green color of chlorophyll is directly related to the retention of magnesium in the pigment molecules. During moist heat treatment, it is converted to pheophytin due to loss of magnesium. The color becomes an olive green instead of grass green. However, this conversion of magnesium can be controlled by changing the medium to slightly alkaline (Ur-Rehman & Awan 2012).

Table 3. Effects of storage on anthocyanin content of dehydrated cauliflower

Treatments	Total anthocyanin (µg/g)					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T_1	17.23^{b}	16.70^{a}	14.03^{a}	12.23^{ab}	15.77^{a}	12.55^{a}
T_2	18.62^{a}	16.43^{b}	13.32^{b}	12.99^{a}	9.72^{b}	4.90^{b}
T_3	14.49^{c}	13.02^{c}	10.08^{c}	10.03^{c}	7.77^{b}	5.52^{b}
T_4	6.26^{d}	4.09^{d}	3.80^{d}	1.99^{d}	1.55^{c}	1.22^{b}
LSD at 5%	3.61	3.63	3.32	3.46	3.79	3.46
Level of significant	*	*	*	*	*	*
CV (%)	5.35	2.39	1.95	1.99	2.22	2.18

In the column, values having a similar letter(s) are statistically identical and those having the dissimilar letter(s) differ significantly at 5% level of probability analyzed by Tukey. T_1= glass jar storage, T_2= plastic jar storage, T_3= polythene bag storage and T_4= open petridish storage. DAS= Days after storage; *= Significant at 5% level of probability; CV= Co-efficient of variation.

Total phenol content (mg/100g)

A significant decrease in total phenol content (TPC) was observed in all the treatments during storage of dehydrated cauliflower (Table 4). Dehydrated cauliflower stored in glass jar (T_1) showed the highest phenolic content both in 15 days (1.42 mg/100g) and 90 days after storage (0.73 mg/100g). The lowest phenolic content (0.37 mg/100g) at 15 days and (0.07 mg/100g) at 90 days after storage was found in the cauliflower sample stored in open petridish (T_4). This finding showed similarity with the findings of Panda *et al.* (2016). Vegetables of Brassicaceae family are the essential sources of phenolic compounds in the human diet (Jahangir *et al.* 2009). The contents of phenolic compounds such as ferulic acid, chlorogenic acid, gallic acid and, catechin in cauliflower were decreased drastically during the irrespective treatment and packaging but the proper packaging retained the quality of the phenolic compounds compared to untreated one (Raja *et al.* 2011). Generally, there were decreasing trends during the different stages of the development but in storage, the phenolic content decreased drastically. According to the results, the major TPC losses were due to the drying process, although storage during 3 months also caused slight reductions in this parameter. TPC losses of 3–25% were also reported in previous studies with galega kale after 12 months of storage (Korus 2011). Polyphenols decreased by 13–56% when analyzed after reaction with Folin–Ciocalteau reagent, a colorimetric assay, indicating the reduction of antioxidant compounds in general, including the most reactive phenolic compounds (Mrkic *et al.* 2006). Blanching significantly reduced the TPC levels by 10–21% in vegetables (Puupponen-Pimia *et al.* 2003).

Table 4. Effects of storage on phenol content of dehydrated cauliflower

Treatments	Total phenol content (mg/100g)					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T_1	1.42^{a}	1.41^{a}	1.21^{a}	1.02^{a}	0.89^{a}	0.73^{a}
T_2	1.14^{b}	1.12^{b}	1.05^{b}	0.98^{b}	0.75^{b}	0.72^{a}
T_3	0.89^{c}	0.89^{c}	0.80^{c}	0.75^{c}	0.67^{c}	0.53^{b}
T_4	0.37^{d}	0.29^{d}	0.17^{d}	0.15^{d}	0.14^{d}	0.07^{c}
LSD	1.03	1.01	1.00	0.97	0.88	0.85
Level of significance	*	*	*	*	*	*
CV (%)	0.32	0.23	0.80	0.03	0.09	0.01

In the column, values having a similar letter(s) are statistically identical and those having the dissimilar letter(s) differ significantly at 5% level of probability analyzed by Tukey. T_1= glass jar storage, T_2= plastic jar storage, T_3= polythene bag storage and T_4= open petridish storage. DAS= Days after storage; *= Significant at 5% level of probability; CV= Co-efficient of variation.

Total antioxidants content (µg/g)

Vegetables of the Brassicaceae family contain derivatives of hydroxycinnamic, caffeic, chlorogenic, ferulic, and synapic acids as well as flavonols (kaempferol derivatives, and quercetin derivatives) and anthocyanins (red cabbage) (Jahangir *et al.* 2009). The consumption of fruits and vegetables is getting more popular because of their health benefits, so that edible films based on these plant materials denote an alternative means of nutrient intake (Espitia *et al.* 2014), including pigments and polyphenols with antioxidant capacity (Deng & Zhao 2011). During storage, at 15 DAS the highest value (0.021) of antioxidant was found in treatment T_3 (polythene bag) and it was gradually decreased. Conversely, the lowest (0.019 µg/g) value was found in treatment T_4 (open petridish). After 3 months storage of dehydrated cauliflower the highest value of antioxidant (0.015 µg/g) was found in treatment T_3 (polythene bag) and the lowest (0.008 µg/g) value in treatment T_2 (plastic jar) (Fig. 4). The results indicate a gradual decrease in antioxidant content during storage (Fig. 4). After the blanching process, a lot of antioxidant substances were running off into the boiling medium, which resulted in the decrease of their antioxidant capacities (Francisco *et al.* 2010). Water boiling and water blanching processes had a great effect on the nutrient components and caused significant losses of dry matter, protein, mineral and phytochemical contents

(Ahmed & Ali 2013). During cooking, qualitative changes, antioxidant breakdown, and their leaching into surrounding water may influence the antioxidant activity of the vegetables (Podsedek 2007).

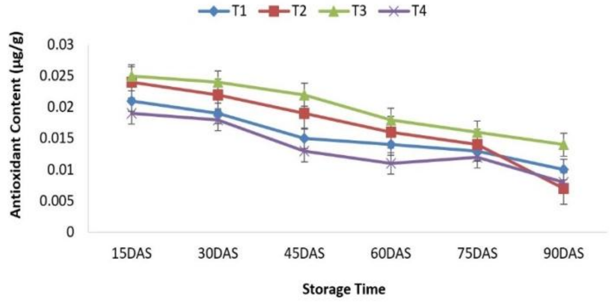

Figure 4: Relationship between antioxidant content and storage duration of dehydrated cauliflower. Vertical bar represents standard error. T_1= glass jar storage, T_2= plastic jar storage, T_3= polythene bag storage and T_4= open petridish storage.

Total soluble carbohydrate (CHO) content (g/100g)

The value of carbohydrate content was decreased gradually during the storage of dried cauliflower (Fig. 5). After three months of storage, the highest value of carbohydrate (16.0g/100g) was found in the cauliflower stored in open petridish (T_4) and the lowest (4.73g/100g) was found in the cauliflower stored in glass jar (T_1). Ur-Rehman & Awan (2012) also found similar major losses of carbohydrates taken place during storage of fruits and vegetables.

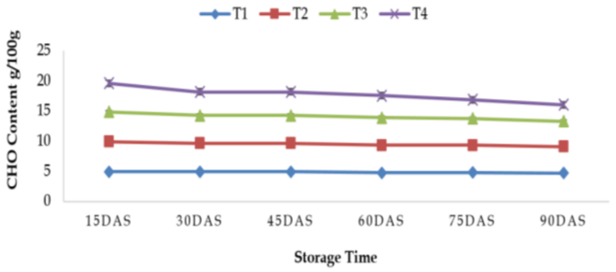

Figure 5: Relationship between carbohydrate (CHO) content and storage duration of dehydrated cauliflower. Vertical bar represents standard error. T_1= glass jar storage, T_2= plastic jar storage, T_3= polythene bag storage and T_4= open petridish storage.

Microbial profile

E. coli

No microbial colony (*E. coli*) was observed in the both case of cauliflower suspensions prepared from fresh cauliflower and 3 months old dehydrated cauliflower. Commonly cauliflower has increased mesophilic aerobes microflora which was reduced during the storage condition. In Low-density polyethylene (LDPE) bags which were build up by carbon dioxide have the antimicrobial activity to reduce the microbial flora on the packaging material of the cauliflower (Raja *et al.* 2011).

Fungal growth

After 90 days of storage of dehydrated cauliflower, fungal growth was observed only in the cauliflower samples stored in open petridish (T_4). The quality of the dehydrated cauliflower was the best in the samples stored in a plastic jar (T_2), and no fungal growth was observed in any other treatments. A wide range of microorganisms exist naturally on the surfaces of fruits and vegetables and they could colonize in a growing medium. These types are useful for monitoring the hygiene system or evaluating the impact of certain sanitary measures (Albrecht *et al.* 1995). High CO_2 concentration effectively retarded microbial growth in low permeable polyamide or polyethylene samples of broccoli (Cefola *et al*. 2010). Fungal decay was least in polypropylene (PP) bag with no perforation while there was no decay in unpacked broccoli while sensory analysis gave the best smell as well as texture score in PP with no perforation which is the most important acceptability criteria (Chanbisana and Banik 2019). Dauthy (1995) found that due to the high moisture content of a product, above equilibrium relative humidity corresponding to water activity, wa = 0.70 microorganisms form a colony.

Microorganisms need moisture for their metabolic activities and multiplication. While yeasts and bacteria require higher amounts of moisture, typically above 30%, molds need much less, 12% moisture or even lower. Some can grow on food substrates even having less than 5% moisture. Fruits are dried to between 16 to 25% moisture. There are chances of mold growth if these are exposed to air and stored under high-humidity conditions. Above 2% moisture and under favorable conditions, mold growth is expected. The most effective control is the use of high-quality vegetables with low contamination, blanching before drying, processing in a hygienic environment, and storage under conditions where the dried foods are protected from invasion of microbes, insects, rodents, and other animals (Gallardo-Guerrero *et al*. 2010).

Conclusion

Rotting and yellowing are the main problems in the post-harvest life of cauliflower which leads the unmarketability of the crop in the market due to consumer dislike. Though cauliflower has year-round demand, they are not available in the market all the year due to a lack of proper processing and storage facilities. Shelf-life extension of cauliflower through drying and using conventional storage techniques could be an alternative way to meet the demand. Among the various conventional storage techniques used in this study, dehydrated cauliflower stored in a glass jar showed significant results relating to total phenol content, anthocyanin content, p^H value, titratable acidity, moisture content, and hygiene compared to others during 3 months of storage. Therefore, storage of dehydrated cauliflower in a glass jar could be an economically viable technology for extending the shelf life and marketability of cauliflower.

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