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EFFECT OF DIFFERENT DRYING METHODS ON CHEMICAL AND FUNCTIONAL PROPERTIES OF MARIGOLD PETALS

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ABSTRACT

Influence of different drying methods on chemical constituents and functional properties of marigold petals from three varieties viz. *Pusa Basanti*, *Pusa Narangi* and *Solan1* was studied. The marigold flower petals were dried by four methods viz Vacuum drying, cabinet drying, fan drying and solar drying. The chemical constituents analyzed were protein %, ash %, and crude fiber %. There was found to be significant increase in all the chemical constituents irrespective of the drying method and variety. The functional properties analyzed were β- carotene, total phenols and antioxidant activity. There was found to be significant increase in β- carotene, where as total phenols and antioxidant activity decreased significantly in case of all the drying methods and the variety as well. The color of the petals was also analyzed where 'L' and 'b' values for color decreased significantly where as 'a' values increased significantly for all the methods of drying and for all the three varieties. Overall vacuum dried samples retained better quality but the cabinet dried samples had comparative quality but was found more economical.

Key words: Marigold flower, drying, chemical constituents, functional properties, color

INTRODUCTION

Marigold (*Tagetes erecta L.*) is an herb of ancient medicinal repute. It grows as a wild and common garden plant throughout Europe, North America and Asia. It has long been used as a food and as an ingredient in animal feed. Marigold has also been used as medicinal plant as it has been reported to have therapeutic properties, such as anti-mutagenicity, anti-inflammatory, anti-tumouroegnic, antiviral and immunostimulating effects (Gonzalez de Mejia *et.al*., 1997; Hamburger *et.al*., 2003). The pharmacological activities of marigold are related to the content of several classes of secondary metabolites such as flavonoids, sterols, carotenoids, tannins, saponins, triterpene alcohols, polysaccharides, a bitter principle, mucilage and resin (Jacobs *et al*., 1994; Piccagliy *et al*., 1998). Because marigold contains polyphenols, the assessment of its antioxidant properties is of great interest in understanding the positive effects of these compounds, especially in phytotherapy. Marigold flowers are used as food colorant and ingredient in cooking, they may be used as the fresh petals or as a dried powder, which can be made into tea, spice and medicine (tinctures, ointments and creams) (Gonzalez de Mejia *et al*., 1997). An extract of marigold flower has been used commercially as an additive to poultry feed to improve the pigmentation of the bird's fat, skin and egg yolk (Bailey & Chen, 1989). Previous studies (Narahari *et al*., 1981; Ojeda *et al*., 1983) have reported that marigold petal and residue consist of xanthophylls, namely lutein and zeaxanthin, which can be used to improve egg yolk colour as a pigmenting agent. Hasin *et al*. (2006) reported that the differences in yolk colour scores were highly significant between marigold and other (orange skin and control diet) dietary groups because the birds on the 4% marigold diet consumed more xanthophylls. Marigold flower petals are an excellent and important source of carotenoids, particularly the yellow carotenoids such as β-carotenes and the xanthophylls, lutein and zeaxanthin.

Drying is an important process for handling raw materials in order to prolong shelf life, as the drying process inhibits enzymatic degradation and limits microbial growth (Ahrne *et.al*., 2007; Pan *et.al*., 1999). Hot air (HA) drying is the most commonly employed commercial technique for drying vegetables and fruits. Heated air is blown in from different directions, depending on the nature of the products being dried (Afzal & Abe, 1999). Vacuum drying is an existing technology that is able to retain product quality, yet providing all the benefits of dried foods in terms of shelf life, transport and storage costs. However, the major disadvantage of vacuum drying is its relatively high cost (Chan *et al*., 2009).

However there have been no published reports on the effects of vacuum drying, hot-air drying, solar drying and fan drying on the chemical, functional and antioxidant

properties of marigold. Therefore, the aim of this study was to investigate the influence of these drying methods on marigold petals from three Indian varieties viz. *Pusa Basanti*, *Pusa Narangi* and *Solan 1* with respect to color, bioactive compounds like total phenolic compounds and β-carotene and chemical constituents like protein, ash, fat and fibre .The antioxidant properties of all treated samples were also evaluated. We thus expected to determine which method is best for drying marigold petals to preserve the above qualities with the minimal cost.

MATERIALS AND METHODS

MATERIALS

Marigold flowers from three varieties viz. *Pusa Narangi*, *Pusa Basanti* and *Solan1* were obtained from Department of Landscape and floriculture Punjab Agricultural University Ludhiana, Punjab, India. The petals from all the three varieties of marigold flowers were detached and washed to remove the adhering dust or dirt. Subsequently the drying of marigold flower petals was carried out by the four methods.

SOLAR DRYING

Solar drying of marigold flower petals was carried out using a solar dryer. The solar dryer used for study was of domestic type with natural convection (Vishivkarma Solar Energy corporation, Ludhiana). The prepared samples were spread in single layer on the three wire –mesh trays of 57×15cm size of natural convection solar dryer. The trays were covered and placed inside the dryer which was kept facing the sun. The direction of the dryer was changed periodically. The position of trays was also interchanged. The samples were dried to constant weight which was achieved in 4-6 hours.

FAN DRYING

Fan drying of marigold flower petals was carried out under ambient conditions of 35±5^{o}C of room temperature.

HOT AIR (CABINET) DRYING

Petals were detached weighed, washed thoroughly under running tap water and surface water was dried. They were transferred to the trays of cabinet drier. The hot air (cabinet) dryer (*Narang* scientific works, New Delhi) used for the drying had the capacity for twelve trays. The dryer was equipped with an exhaust outlet. Marigold flower petals were spread evenly in a single layer on trays. These trays were placed inside the hot air (cabinet) dryer maintained at 40 ±5◦C. The position of trays was interchanged periodically and the marigold flower petals were dried till constant weight was attained.

VACUUM DRYING

Vacuum drying of marigold flower petals was carried in vacuum oven (BINDER Gmbh) at the temperature of 50^{o}C and vacuum of 50 mbar till the desired moisture was obtained. The oven had an electro polished inner chamber, two rack holders and was equipped with vacuum system ranging from 0 to 1000 mbar, temperature control and pressure and temperature gauges. All the unit's vacuum connections and valves were made of especially corrosion resistant steel. The marigold flower petals were spread evenly in a single layer on small aluminum trays.

CHEMICAL CHARACTERISTICS OF DRIED MARIGOLD PETALS

The marigold petals were ground to form a powder to pass through 25 mesh sieve. The powder was analyzed various chemical constituents like moisture content, protein, ash, and crude fibre by Standard AACC (2000) methods.

FUNCTIONAL CHARACTERISTICS OF MARIGOLD PETALS

Functional characteristics of marigold petal powder analyzed were color, antioxidant activity, β-carotene and total phenol content.

COLOR MEASUREMENT

Color changes parameters of sample was measured by a Minolta CR-300 Chroma Meter (Konica Minolta, Osaka, Japan) in 'L', 'a', 'b' color scales. The 'L'-value exhibits brightness where as positive and negative 'a' values determine the redness and greenness, and positive and negative 'b' values determine yellowness and blueness, respectively .The instrument was calibrated against a white standard. Measurements were individually taken for ten samples per treatment and the average of ten readings was calculated.

SAMPLE EXTRACTION PROCEDURE

One gram of marigold petal powder was extracted with 50 mL of 80% methanol refluxing by at 50^{0}C temperature for 2 hours. The samples were filtered and residue was again refluxed for 1 hour with 40 ml of 80 % methanol and volume made to 100 ml with 80 % methanol. Filtrate was used for antioxidant activity test and total phenol content

DETERMINATION ANTI-OXIDANT CAPACITY MARIGOLD FLOWER POWDER

Radical scavenging activity of marigold petal powder from different varieties against stable DPPH (2,2-diphenyl-2- picrylhydrazyl hydrate) was determined spectrophoto-metrically. When DPPH reacts with an antioxidant compound, which can donate hydrogen, it is reduced. The changes in color (from purple to light yellow) were measured at 517 nm on a UVvisible light spectrophotometer. Radical scavenging activity of extracts was measured by methods as described below. The antioxidant activities of all extracts were evaluated through free radical scavenging effect on 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical. The determination was

based on the method proposed by Akowuah *et al* (2005). Percentage of DPPH scavenging activity was calculated as % inhibition of DPPH = [Abs control –Abs sample / Abs control] x 100.

DETERMINATION OF TOTAL PHENOLICS CONTENT

Total phenolic contents of all plants extracts were determined using Folin-Ciocalteu reagent as described by Singlaton and Rossi (1965). Samples were inserted into different test tube and mixed thoroughly with 5 ml Folin-Ciocalteu reagent (previously pre-dilute 10 times with distilled water). After 5 mins, 4 ml of 7.5% sodium carbonate was added and allowed to react for 2 hrs at room temperature. The absorbance was measured at 765 nm using spectrophotometers. Samples were measured in three replicates. Standard curve of gallic acid solution (10, 20, 40, 60, 80 and 100 ppm) was prepared using the similar procedure. The results were expressed as mg GAE/100 g extract sample.

EXTRACTION OF CAROTENOID PIGMENTS

Sample (1 g of sample of marigold petal powder) was extracted with acetone in a pestle and mortar using sodium sulphate until the residue was colorless. This extract was then transferred to separatory funnel and 10-15 ml of petroleum ether was added. Pigments were transferred to the petroleum ether phase by diluting the acetone by water. Extraction of acetone phase with small volume of petroleum ether was repeated till colorless. Petroleum ether extract was filtered and transferred to 25 ml volumetric flask and volume was made up to the mark with petroleum ether. The total carotenoids were estimated by measuring the O.D of the extract at 452 nm using petroleum ether as blank (Ranganna 1986).

SEPARATION OF B-CAROTENE

a) PREPARATION OF COLUMN

A glass column 20 cm length and 1 cm diameter was taken. The column was prepared by plugging it with glass wool. The column was filled upto 10 cm height with aluminium oxide, which was activated by drying in oven for 2 h at 100°C to be free from moisture. The column was tapped while filling to pack it tightly so that no air spaces were left. One cm layer of Na_2SO_4 was added over the top of the column.

b) ADSORPTION AND ELUTION

The column was washed with 50 ml 3 % acetone in petroleum ether. While the last ml of eluent was still above the Na_2SO_4, 5 ml of the extract was loaded on to the column carefully. β- carotene moved off the column prior to all other pigments. Column was washed with eluent till the desired pigments have moved off the column and the eluent is colorless. The extract was collected in the 10 ml volumetric flask and the volume was made up with 3 % acetone in petroleum ether. The intensity of the color was then read at 452 nm in spectrophotometer using 3 % acetone in petroleum ether as blank (Ranganna 1986).

$$\text{mg of } \beta \text{ carotene per } 100g = \frac{\text{Conc. of } \beta \text{ carotene from std. x final vol. x dilution factor}}{\text{Weight of sample}} \times 100$$

STATISTICAL ANALYSIS

Data was analyzed with the help of CPCS-I Statistical software using two-way ANOVA.

RESULTS AND DISCUSSION

EFFECT OF DIFFERENT METHODS OF DRYING ON CHEMICAL CONSTITUENTS OF MARIGOLD PETALS

The dried marigold flower petals obtained from three varieties namely *Pusa Basanti*, *Pusa Narangi* and *Solan 1* by different methods of drying viz Vacuum drying, Cabinet drying, Solar drying and Fan drying were analyzed for chemical parameters like protein %, ash %, fiber % and functional parameters like total Phenol content (mg GAE/g), β carotene (mg/100g) and antioxidant activity (%). The data are presented in Table 1.

Table 1: Effect of drying on chemical constituents of marigold petals

Drying method	Variety	Protein (%)	Ash (%)	Fiber (%)
Fresh	*Pusa Basanti*	2.00±0.60	0.45±0.10	1.67±0.72
	Pusa Narangi	2.22±0.51	1.40±0.77	0.64±0.63
	Solan 1	2.13±0.62	1.90±0.72	0.58±0.59
Vacuum dried	*Pusa Basanti*	4.28±0.63	3.20±0.45	10.9±1.52
	Pusa Narangi	2.40±0.64	4.40±0.54	15.51±1.35
	Solan 1	2.68±0.50	4.80±0.39	14.83±2.33
Cabinet dried	*Pusa Basanti*	3.40±0.40	2.02±0.45	12.50±1.35
	Pusa Narangi	3.70±0.45	2.80±0.56	14.50±2.54
	Solan 1	3.80±0.43	2.70±0.29	14.70±1.50

Fan dried	*Pusa Basanti*	2.15±0.35	3.60±0.48	13.00±2.62
	Pusa Narangi	2.40±0.32	2.50±0.45	15.40±2.29
	Solan 1	2.25±0.41	2.79±0.49	15.50±3.05
Solar dried	*Pusa Basanti*	3.50±0.36	5.02±0.57	14.37±1.47
	Pusa Narangi	3.10±0.23	5.80±0.28	20.70±3.47
	Solan 1	3.02±0.34	5.50±1.08	19.53±2.49
CD($p \leq 0.05$)	Drying Method (A)	0.44	0.47	0.95
	Variety (B)	NS	0.36	0.74
	A×B	0.77	0.82	1.66

Values are means ± SE of three independent determinations.

The values for % protein content increased significantly as compared to fresh sample irrespective of method of drying. The values for protein content among the varieties varied non significantly. The values for protein content increased from 2.0 % for fresh petals for *Pusa Basanti* to 4.28 % for vacuum dried, 3.5 % for solar dried, 3.4 % for cabinet dried and 2.15 % for fan dried petals. Similarly for *Pusa Narangi* the Protein content was 2.22 % for fresh sample which increased to 2.4 % for vacuum dried, 3.7 % for cabinet dried, 2.4 % for fan dried and 3.1 % for solar dried samples. For the variety *Solan 1* the values for protein content for fresh sample was 2.13 % which increased to 2.68 % for vacuum dried, 3.8 % for cabinet dried 2.25 % for fan dried and 3.02 % for solar dried samples.

The ash content of the dried sample also increased significantly as compared to fresh samples irrespective of variety and method of drying. The value for ash content for fresh petals of *Pusa Basanti* was 0.45 % which increased to 3.2 % for vacuum dried, 2.02 % for cabinet dried, 3.6 % for fan dried and 5.02 % for solar dried petals. The ash content for the petals of *Pusa Narangi* showed the similar trend. The fresh petals showed the ash content of 1.4 % followed by 4.4 % for vacuum dried, 2.8 % for cabinet dried 2.5 % for fan dried and 5.80 % for solar dried petals. The variety *Solan 1* showed similar trend. The fresh petals showed an ash content of 1.9 %. The vacuum dried petals from *Solan 1* variety showed an ash content of 4.8 %. The cabinet dried petals showed an ash content of 2.7 %, fan dried showed an ash content of 2.79 % and solar dried petals from *Solan 1* showed an ash content of 5.50 %.

Fibre content increased significantly for all the three varieties and all the four methods of drying. For the freshpetals of *Pusa Basanti* the fibre content was 1.67 %. It increased to 10.9 % for vacuum dried, 12.5 % for cabinet dried, 13.0 % for fan dried and 14.37 % % for solar dried petals. Fresh petals from *Pusa Narangi* variety showed a fibre content of 0.64 %. the vacuum dried petals showed fibre content of 15.5 %, cabinet dried had a fibre content of 14.5 %, fan dried had 15.4 % solar dried had a fibre content of 20.7 %. The variety *Solan 1* also showed a similar trend. The fibre content for fresh petals from the variety *Solan 1* showed a fibre content of 0.58 %. This value increased to 14.83 % for vacuum dried petals, 14.7 % for cabinet dried, 15.5 % for fan dried petals and 19.53 % for solar dried petals.

Similar results for dehydration of onion leaves by cabinet drying, freeze drying and microwave drying were reported. It was concluded that dehydrated leaves showed higher mean values for ash, crude fiber and protein as compared to fresh leaves. Reason for this increase was loss of moisture caused the condensation of the nutrient in the leaves Kushwaha (2012).Sun-drying increased the protein, fiber and total ash content of the leafy vegetables Mepba *et al* 2007

EFFECT OF DIFFERENT METHODS OF DRYING ON FUNCTIONAL PROPERTIES OF MARIGOLD PETALS

The dried marigold flower petals obtained from three varieties namely *Pusa Basanti*, *Pusa Narangi* and *Solan 1* by different methods of drying viz Vacuum drying, Cabinet drying, Solar drying and Fan drying were analyzed for functional parameters like total Phenol content (mg GAE/g), β carotene (mg/100g) and antioxidant activity (%). The data are presented in Table2. The total phenol content of fresh and dried marigold flower petals was analyzed. Total phenol content decreased significantly in dried samples as compared to fresh samples. The total phenol content in *Pusa Basanti* was 109.4 mg GAE/g in fresh which decreased to 20.2 mg GAE/g in vacuum dried, 16.63 mg GAE/g in cabinet dried 45.8 mgGAE/g in fan dried, 47.4 mg GAE/g in solar dried sample.

In *Pusa Narangi* the value for total phenol content for fresh sample was 112.2 mg GAE/g which decreased to71.6 mg GAE/g for vacuum dried, 60.8 mg GAE/g for cabinet dried 46.4 mg GAE/g for fan dried, 45 mg GAE/g for solar dried sample. The variety *Solan 1* showed the similar trends. Total phenol content was 110.5 mg GAE/g in fresh sample which decreased to 74.8 mg GAE/g for vacuum dried, 95.3 mg GAE/g for cabinet dried 49.3 mg GAE/g for fan dried and 70.8 mg GAE/g for solar dried sample.

β-carotene content of the dried sample increased significantly with decrease in moisture content as compared to fresh sample irrespective of drying method and variety. The β carotene content in fresh petals for *Pusa Basanti* was 0.254 mg/100g which increased to 17.48 mg/100g for vacuum dried, 4.5 mg/100g for cabinet dried, 6.72 mg/100g for fan dried and 7.76 mg/100g for solar dried samples. The value for β carotene for the variety *Pusa Narangi* for fresh petals was 2.96 mg/100g, which

increased to 30.88 mg/100g for vacuum dried, 6.84 mg/100g for cabinet dried, 17.76 mg/100g for fan dried and28.88 mg/100g for solar dried petals.Variety *Solan 1* also showed the similar trend. The value for β carotene for fresh sample was 3.81 mg/100g which increased to 24.93 mg/100g for vacuum dried, 7.93 mg/100g for cabined dried, 18.93 mg/100g for fan dried and 29.103 mg/100g for solar dried petals.

Antioxidant activity also showed a significantly decreasing trend in dried samples as compared to fresh samples for all drying methods and also the varieties. The antioxidant activity for fresh petals of *Pusa Basanti* was 31.98 % which decreased to 29.44 % for vacuum dried, 31.89 % for cabinet dried, 25.04 for fan dried and 29.84 % for solar dried petals. For the variety *Pusa Narangi* the fresh petals showed an antioxidant activity of 37.56 % which decreased to 30.68 % for vacuum dried, 33.65 % for cabinet dried, 30.45 % for fan dried and 33.16 % for solar dried samples.

The variety *Solan 1* also showed a decrease in value of antioxidant activity after drying as compared to fresh samples. The value of antioxidant activity for fresh petals was 36.83 % which decreased to 31.25 % for vacuum dried, 35.89 % for cabinet dried, 30.68 % for fan dried and 33.93 % for solar dried petals. Similar results have been reported by Siriamornpun *et al* (2012). They reported that hot air dried samples of marigold flower petals showed the high concentration of β carotene. Further they also reported that phenolic components differ from one another with respect to their binding status so the drying processes may differ in their effectiveness in liberating phenolic acids from plant tissues. The antioxidant activity for fresh marigold flowers was 65 % which reduced to 52.4 % in hot air dried marigold petals.

CHANGES IN COLOR OF FRESH AND DRIED MARIGOLD PETALS

The data regarding changes in color after drying of Marigold flower petals from three varieties are presented in Table 2. The 'L' values for the dried samples decreased significantly with the drying method but the variation with respect to variety was found to be non-significant. The 'L' values for the fresh petals of *Pusa Basanti* was 63.86 which decreased to 48.60 for vacuum dried, 38.5 for fan dried, 44.9 for solar dried and 49.56 for cabined dried petals. For the variety *Pusa Narangi* the 'L' value decreased from 61.95 for fresh to 46.54 for vacuum dried, 38.23 for fan dried, 38.23 for solar dried and 45.08 for cabinet dried petals. 'b' values for the same variety decreased from 19.86 for fresh to 13.3 for vacuum dried, 8.80 for fan dried, 8.59 for solar dried and 6.67 for cabinet dried samples.Variety *Solan 1* also showed a similar trend whereby the value of L for fresh petals was 60.32 which decreased to 47.06 for vacuum dried, 39.41 for fan dried 39.48 for solar dried and 46.79 for cabinet dried petals.

Table 2: Effect of drying on functional properties of marigold petals

Drying method	Variety	Total phenol (mg GAE/g)	β carotene (mg/100 g)	Anti-oxidant activity (%)
Fresh	*Pusa Basanti*	109.4±4.72	0.254±0.10	31.98±3.00
	Pusa Narangi	112.2±4.82	2.96±0.51	37.56±2.64
	Solan 1	110.5±4.45	3.81±0.45	36.83±3.10
Vacuum dried	*Pusa Basanti*	20.2±4.91	17.48±0.31	29.44±3.00
	Pusa Narangi	71.6±4.68	30.88±3.10	30.68±2.64
	Solan 1	74.8±3.72	24.93±0.48	31.25±3.10
Cabinet dried	*Pusa Basanti*	16.6±4.35	4.5±2.64	31.89±3.00
	Pusa Narangi	60.8±4.63	6.84±0.52	33.65±2.64
	Solan 1	59.3±3.49	7.93±0.45	35.89±3.10
Fan dried	*Pusa Basanti*	45.8±2.16	6.72±0.50	25.04±3.00
	Pusa Narangi	46.4±4.82	17.76±0.49	30.45±5.60
	Solan 1	49.3±4.63	18.93±0.50	30.68±3.00
Solar dried	*Pusa Basanti*	40.4±4.40	7.76±0.49	29.84±3.00
	Pusa Narangi	45.0±6.00	28.88±0.47	33.16±3.10
	Solan 1	47.8±5.80	29.10±0.47	33.93±3.00
CD(p≤0.05)	Drying Method (A)	4.25	1.09	3.08
	Variety (B)	3.29	0.84	2.38
	A×B	7.36	1.89	NS

Values are means ± SE of three independent determinations.

Table 3: Effect of drying on color 'L' ' a' ' b' values of marigold flowers

Drying method	Variety	L	a	b
Fresh	*Pusa Basanti*	63.86±4.60	3.48±10.50	52.93±1.70
	Pusa Narangi	61.95±3.47	13.25±1.45	19.86±1.80
	Solan 1	60.32±4.82	12.09±2.55	20.34±1.90
Vacuum dried	*Pusa Basanti*	48.60±3.72	7.09±0.68	16.13±1.40
	Pusa Narangi	46.56±4.45	14.74±2.40	13.98±1.30
	Solan 1	47.06±3.70	17.15±0.50	11.65±1.25
Cabinet dried	*Pusa Basanti*	38.50±4.40	4.83±0.30	13.98±1.45
	Pusa Narangi	38.23±5.50	18.72±0.26	8.80±0.25
	Solan 1	39.41±2.00	10.28±1.50	7.48±0.14
Fan dried	*Pusa Basanti*	44.90±6.00	4.27±0.16	9.92±0.32
	Pusa Narangi	38.23±3.80	17.60±0.20	8.59±0.26
	Solan 1	39.48±4.00	18.36±0.40	7.29±0.15
Solar dried	*Pusa Basanti*	49.56±3.30	4.67±0.18	8.15±0.58
	Pusa Narangi	45.08±3.50	15.8±1.90	6.67±0.22
	Solan 1	46.79±3.40	16.32±0.17	5.83±0.28
CD ($p \leq 0.05$)	Drying Method (A)	3.91	1.83	1.43
	Variety (B)	NS	1.52	1.10
	A×B	NS	3.17	2.47

Values are means ± SE of three independent determinations.

The 'a' values for the dried samples increased significantly with drying method. Also the variation with respect to variety was found to be significant. 'a' values for the variety *Pusa Basanti* were 3.48 for fresh sample which increased to 7.09 for vacuum dried, 4.83 for cabinet dried, 4.27 for fan dried and 4.67 for solar dried samples. 'a' values for *Pusa Narangi* increased from 13.25 for fresh to 14.74 for vacuum dried,18.72 for cabinet dried, 17.60 for fan dried and 15.85 for solar dried petals. For the variety *Solan 1* 'a' value of the fresh sample was 12.09 for the fresh sample which increased to14.74 for the vacuum dried sample, 10.28 for cabinet dried 18.36 for fan dried sample and 16.32 for solar dried sample.

'b' values also decreased significantly with respect to fresh sample irrespective of the drying method and the variety. 'b' value for the fresh sample of *Pusa Basanti* was 52.93 which decreased to 16.13 for vacuum dried sample,13.98 for cabinet dried sample,9.92 for fan dried sample and 8.15 for solar dried samples. The variety *Pusa Narangi* showed a similar trend with the 'b' value of with 19.86 for fresh which decreased to 13.98 for vacuum dried, 8.80 for cabinet dried, 8.59 for fan dried and 6.67 for solar dried samples . 'b' values for the variety Solan I 20.34 for fresh petals which decreased to 11.65 for vacuum dried,7.48 for cabinet dried, 7.29 for fan dried and 5.83 for solar dried samples. Siriamornpun (2012) reported the similar results and concluded that the color changes in marigold caused by the thermal process might be caused not only by non-enzymatic browning reaction but also by the destruction of pigments present in petals.

CONCLUSION

The results revealed that the vacuum drying gave the best results from the preservation of quality with respect to chemical and functional constituents' point of view. But this is an expensive method for drying of marigold petals. Therefore from quality and economics viewpoint the second best method was found to be cabinet drying.

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