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Proximate Constituent Analysis and Antioxidant Activity of Annual Edible Flowers

R. Atchaya[1], Thaneshwari[1], Keerthi Prakash[1]

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ABSTRACT

Background: Flowers are not only for their ornamental, aesthetic purpose but it is a great nutritious to human diet and health. These are rich source of pigments and possess antibacterial and antioxidant properties. Few flowers are used traditionally in diet and there is huge scope to use edible flowers in nutraceutical, pharmaceutical and pigment industry. But very less research has been done till date for finding proximate constituent, antioxidant activity and mineral profiling of edible annual flowers. The present work investigated the proximate constituent analysis and antioxidant activity of few annual flowers.

Methods: In this laboratory analysis, different annual flowers were used for the experiment. They were *Celosia cristata* var. Deep Armor Purple, *Celosia cristata* var. Twisted Orange, *Celosia cristata* var. Pink, *Celosia argentea* var. Cristata Yellow, *Celosia argentea* var. Plumosa, *Celosia cristata* var. Bombay Pink, *Gomphrena globosa*, *Gallardia pulchella*, *Tagetes erecta, Tagetes patula* and *Calendula officinalis*. Proximate constituent analysis and antioxidant activity were performed using Association of Official Analytical Chemist (A.O.A.C) methods.

Result: Among the different annual flowers, the maximum ash content (15.58%) the crude protein content (13.45%) and the crude fibre content (13.39%) were found in *Gomphrena globosa* flowers, whereas the minimum ash content (7.24%), the minimum crude protein (6.51%) and the minimum crude fibre content (6.63%) were reported in *Calendula officinalis* flowers. On the other hand, the antioxidant activity was found to be superior in the flowers of *Tagetes patula* (60.34%) followed by *Tagetes erecta* (57.99%) and the minimum antioxidant activity (43.89%) was found in flowers of *Celosia cristata* var. Twisted Orange.

Key words: Antioxidant, Edible, Flowers, Nutrition, Proximate.

INTRODUCTION

Annual flowers are flower crops that complete their life cycle in one season. Many flowers are considered to be edible and these flowers have been consumed by humans since earlier times (Zheng *et al*., 2019). Among those studies, works were done on using the flowers as supplemental functional foods to meet out these deficiencies. Pansy flowers used in desserts, soups, beverages, salad or added as garnish and it is well known for laxative, expectorant, emetic, anti-inflammatory, diuretic, sedative and antiseptic properies (Fernandes *et al*., 2019, Gonçalves *et al*., 2019). *Lonicera japonica* (Honeysuckle) flowers were used in teas which have health benefits against fever, carbuncles and some infection diseases (Liu *et al*., 2020). Edible flowers have been identified as source of various bioactive chemicals, including vitamins, phenolics and carotenoids, all of which are well-known antioxidants (Chensom *et al*., 2019, Singh and Sharma, 2019, Murugeswari *et al*., 2022). These flowers possess a wide range of vital biological properties, including antioxidant activity as well as anticancer, anti diabetic, anti inflammatory, antibacterial and gastroprotective properties. Natural sources of phenolics are of interest because of their antioxidant potential, which has been shown to benefit a variety of chronic disorders, including obesity, diabetes, cardiovascular and neurodegenerative disorder (Dantas *et al*., 2019, Singh *et al*., 2023). Evidences shows that the oxidative stress were the major cause for variety of diseases such as dementia, diabetes, heart stroke and paralysis (Ashok *et al*., 2022). By this view intake of antioxidant rich foods are essential in human diet. Very less research has been done in order to find out the proximate value and antioxidant activity of annual edible flowers, which are otherwise easy to cultivate and has wide adaptability. By keeping in mind, the above-mentioned factors, the present research work aims to find out the proximate constituent and antioxidant activity of some annual edible flower.

[1]Department of Horticulture, Floriculture and Landscaping, Lovely Professional University, Phagwara-144 001, Punjab, India.

Corresponding Author: Thaneshwari, Department of Horticulture, Floriculture and Landscaping, Lovely Professional University, Phagwara-144 001, Punjab, India.
Email: thaneshwari.22822@lpu.co.in

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MATERIALS AND METHODS

Procurement and preparation of plant materials

In this experiment, 11 different flowers, namely (*Celosia cristata* var. Deep Armor Purple, *Celosia cristata var.* Twisted

Orange, *Celosia cristata var.* Pink, *Celosia argentea* var. Cristata Yellow, *Celosia argentea* var. Plumosa, *Celosia cristata* var. Bombay Pink, *Gomphrena globosa, Gallardia pulchella, Tagetes erecta, Tagetes patula, Calendula officinalis*) were used as an experimenal material. The flower crops were sown, transplanted and maintained in agri farm, Department of Horticulture, School of agriculture, LPU, Punjab. Those flowers were dried at room temperature for 5 hours, followed by tray dryer for 8 hours at 55°C.

Proximate constituent analysis

Moisture content

Hot air oven was used to dry petridish at 105°C for 1 h in order to remove the moisture and weighed (W1). The sample (5 g) was then added to petridish and oven dried at 135°C for 2 h and final weight (W2) was taken.

$$\text{Moisture \%} = \frac{Ws - (W2 - W1)}{Ws} \times 100$$

W1 = Weight of petridish.
Ws = Weight of sample.
W2 = Weight of petridish after drying.

Ash content

A porcelain crucible was weighed (W1) after being dried at 105°C for 1 h in hot air oven. The sample (2 g) was added and weighed (W2). The contents were first charred at 250°C for 1 h in hot plate and ashing at 550°C for 5 hours in muffle furnace. Then crucible was cooled in desiccator. The weight of crucible with ash was taken (W3).

$$\text{Ash content \%} = \frac{Ws - (W2 - W1)}{Ws} \times 100$$

W1 = Weight of crucible.
W2 = Sample plus crucible weight.
Ws = Crucible plus ash sample.

Crude lipid

The Soxhlet extraction method was used for crude lipid estimation. 200 ml of petroleum ether was used to extract sample (5 g) (Ws). Weight of empty round bottom flask in soxhlet unit was taken (W1). A thimble was made out of filter paper and sample was added. After addition of solvent, the soxhlet run for 24 hours until there was no more lipid content in sample. After extraction, the flask was placed inside oven at 110°C for 30 mins. After drying weight of flask with fat was taken (W2).

$$\text{Crude lipid \%} = \frac{(W2 - W1)}{Ws} \times 100$$

Ws = Weight of sample.
W1 = Weight of round bottom flask.
W2 = Weight of flask after drying.

Crude fiber

The amount of dietary fibre was determined using an adaptation of acid/base digestion method. 5 g (Ws) of sample was taken after being digested with 100 ml of 0.25 M sulfuric acid by heating for 30 minutes on a hot plate. Using 100 ml of 0.31 M sodium hydroxide solution, the process was repeated. After cooling in desiccator and being dried in oven at 100°C, weighed (W1). The sample was burned for 5 hours at 550°C in muffle furnace and weighed (W2).

$$\text{Crude fiber \%} = \frac{(W2 - W1)}{Ws} \times 100$$

Ws = Weight of sample.
W1 = Weight of fiber residue after drying.
W2 = Weight of residue after burning.

Crude protein

The protein content was estimated by micro Kjeldahl method. 20 ml of concentrated H_2SO_4 and Kjeldahl digestion tablet were boiled along with sample (2 g) until clear mixture was produced. The digest was filtered into volumetric flask of 250 ml. 50 ml of 45% NaOH solution added to prepared digest, was then steam-distilled to extract ammonia. The distillate (150 ml) was collected into conical flask containing 100 ml of 0.1 N Hcl. The collected distillate was back titrated against 0.1N Hcl with methyl orange as an indicator.

Crude protein % = N% × factor

N% = Nitrogen %
Factor = 6.25 (standard factor)
Nitrogen % can be calculated by

$$N\% = \frac{V1 \times Ws \times n1 \times F1 \times MWn}{Ws \times 10}$$

V1= Volume of Hcl consumed.
Ws= Sample weight.
n1= Normality of HCl.
F1= Acid factor.
MWn= Molecular weight of nitrogen.

Total carbohydrate

The amount of carbohydrates calculated by subtracting amount of crude protein, crude fibre, ash and lipid from the total amount of dry matter.

Total carbohydrate = 100 - (% Moisture content + % Total Ash + % crude fat + % crude fibre + % crude protein).

Energy content

The caloric value was determined by multiplying values for crude protein, crude fat and carbohydrate by the standard Atwater factors: 4, 9 and 4 k cal, respectively.

Energy (kcal/100 g) = (Crude protein × 4) + (Crude fat × 9) + (Total carbohydrate × 4)

Antioxidant activity

The antioxidant activity was measured using DPPH technique. The plant extracts were prepared using methanol. 1 ml of methanol was added to extract and 1 ml of DPPH was added to each tube. DPPH in methanol solution without sample was taken as control. The solution's

absorbance was measured at 517 nm after 30 minutes of incubation in dark.

Antioxidant activity =

$$\frac{\text{Absorbance of control - Absorbance of sample}}{\text{Absorbance of control}} \times 100$$

Statistic evaluation

Data was analysed using WASP (Web Agri Stat Package) statistical software which was developed by Agricultural Knowledge Management Unit (AKMU), Ela, Old Goa. The persual of data revealed that there was significant difference among the different flowers for its proximate content and antioxidant activity.

RESULTS AND DISCUSSION

Proximate and Antioxidant activity of edible annual flowers

Moisture content of edible annual flowers

A persual of data presented in Table 1 shows that maximum moisture content (65.98%) was recorded in *Calendula officinalis* followed by *Celosia cristata* var. Bombay Pink (64.38%) and the minimum moisture content (56.59%) was recorded in *Gomphrena globosa* flowers. The current moisture content corroborates with the study by Toliba *et al*. in (2018) on marigold flowers (68.32±0.14%) and in the *Moringa* flowers (63.68 to 71.11%) by (Javed *et al*., 2021).

Ash content of edible annual flowers

A persual of data presented in Table 1 revealed that maximum ash content (15.58%) was recorded in *Gomphrena globosa* followed by *Gallardia pulchella* (13.59%) and minimum ash content (7.24%) was recorded in *Calendula officinalis* flowers. The current study findings agree with the results performed by Arefin *et al*. (2015) and found values of ash content (7.98%) from asteraceae family flowers and corroborate with findings by Jadouali *et al*. (2019) from flower parts of Moroccan *Crocus sativus.*

Crude protein of edible annual flowers

The data presented in the Table 1, revealed that maximum crude protein content (13.45%) was recorded in *Gomphrena globosa* followed by *Celosia argentea* var. Plumosa (13.22%) and the minimum crude protein content (6.51%) was recorded in *Calendula officinalis* flowers. These results were close to results reported on aster flowers (12.99± 0.46%) by (Arefin *et al*., 2015).

Crude lipid of annual flowers

The data presented in the Table 1 revealed that maximum crude lipid content (14.93%) was recorded in *Gallardia pulchella* followed by *Calendula officinalis* (14.56%) and minimum crude lipid content was recorded in *Celosia argentea* var. Plumosa (11.51%). Similar research was conducted by Ilodibia and co scientists in 2016 in *celosia* leaves and reported lipid content of 10.61±0.00%.

Crude fibre of annual flowers

The data presented in Table 1 revealed that maximum crude fibre content (13.39%) was recorded in *Gomphrena globosa* followed by *Celosia argentea* var. Plumosa (13.26%) and minimum crude fibre content was recorded in *Calendula officinalis* (6.63%). Jakubczyk *et al*. (2022) conducted a study on flowers of *Magnolia* × *soulangeana* and the crude fibre obtained in the range 13.22±0.94% was in the corroborative range as current study.

Total carbohydrate content of annual edible flowers

The data presented in Table 2 revealed that maximum carbohydrate content (21.20%) was recorded in *Celosia argentea* var. Plumosa followed by *Tagetes patula* (19.99%) and the minimum total carbohydrate content was recorded in *Celosia cristata* var. Bombay Pink (10.57%). In *Celosia cristata* flowers, total carbohydrate content was reported as 9.80 1.40% by Sayeed *et al*. (2020) that is in same line with this study. Navarro *et al*. (2014) studied edible flowers and reported carbohydrate content of *Tagetes erecta* as 14.15±1.24% and similar kind to current study.

Table 1: Proximate constituent analysis of annual edible flowers.

Flower sample	Moisture content (%)	Ashcontent (%)	Crude protein (%)	Crude lipid (%)	Crude fibre (%)
Celosia cristata var. Deep armor purple	63.74^{c}	10.88^{d}	10.86^{f}	12.27^{h}	11.19^{e}
Celosia cristata var. Twisted orange	60.28^{g}	9.76^{i}	12.67^{d}	12.44^{g}	9.41^{i}
Celosia cristata var. Pink	61.33^{e}	10.67^{e}	11.99^{e}	13.07^{e}	10.27^{f}
Celosia argentea var. Cristata yellow	63.31^{d}	11.49^{c}	12.82^{c}	12.58^{f}	9.83^{h}
Celosia argentea var. Plumosa	56.76^{j}	8.98^{j}	13.22^{b}	11.51^{k}	13.26^{b}
Celosia cristata var. Bombay pink	64.38^{b}	10.16^{g}	10.88^{f}	11.99^{j}	11.99^{c}
Gomphrena globosa	56.59^{k}	15.58^{a}	13.45^{a}	12.08^{i}	13.39^{a}
Gallardia pulchella	58.19^{i}	13.59^{b}	8.38^{g}	14.93^{a}	11.86^{d}
Tagetes erecta	61.15^{f}	10.21^{f}	7.97^{h}	13.45^{d}	10.16^{g}
Tagetes patula	60.08^{h}	9.94^{h}	8.39^{g}	14.15^{c}	8.36^{j}
Calendula officinalis	65.98^{a}	7.24^{k}	6.51^{i}	14.56^{b}	6.63^{k}
CD (0.01)	0.042	0.048	0.031	0.034	0.036

Table 2: Total carbohydrate, Total energy and antioxidant activity content of annual edible flowers.

Flower sample	Total carbohydrate (%)	Total energy content (kcal/100 mg)	Antioxidant activity (%)
Celosia cristata var. Deep armor purple	11.74^{i}	395.46^{i}	46.18^{j}
Celosia cristata var. Twisted orange	17.99^{d}	456.47^{d}	43.89^{k}
Celosia cristata var. Pink	15.29^{g}	440.64^{f}	55.59^{e}
Celosia argentea var. Cristata yellow	10.88^{j}	474.93^{c}	54.53^{f}
Celosia argentea var. Plumosa	21.20^{a}	564.47^{a}	52.10^{g}
Celosia cristata var. Bombay pink	10.57^{k}	508.47^{b}	57.55^{c}
Gomphrena globosa	16.35^{f}	336.22^{j}	48.01^{i}
Gallardia pulchella	17.75^{e}	398.23^{h}	55.69^{d}
Tagetes erecta	18.10^{c}	449.94^{e}	57.99^{b}
Tagetes patula	19.99^{b}	292.07^{k}	60.34^{a}
Calendula officinalis	14.23^{h}	420.47^{g}	48.75^{h}
CD (0.01)	0.044	0.069	0.015

Total energy content of annual edible flowers

The data in Table 2 shows that maximum total energy content (564.47 kcal/100 g) was recorded in *Celosia argentea* var. *Plumosa* followed by *Celosia cristata* var. Bombay Pink (508.47 kcal/100 g) and the minimum total energy content was recorded in *Tagetes patula* (292.07 kcal/100 g). The similar kind of results were also obtained in proximate composition of *Celosia argentea* which was reported as 435.30±1.06 kcal/100g by (Adegbaju *et al*., 2019). Javed *et al*. (2021), studied about energy value in flowers of M*oringa oleifera* and reported (kcal/100 g) 324.33 ±15.43 to 502.11±17.95. Verma and co workers in 2012, studied about the physico-chemical and nutritional characteristics of *Kachnar* flowers and reported total energy content was 394.88 kcal/100 g.

Total antioxidant activity of annual edible flowers

From data in Table 2 shows that maximum total antioxidant activity (60.34%) was recorded in *Tagetes patula* followed by *Tagetes erecta* (57.99%) and minimum total antioxidant content was recorded in *Celosia cristata* var. Twisted Orange (43.89%). The same kind of research was conducted by Sayeed *et al*., 2020 in *celosia* flowers and reported antioxidant value as 68.7±0.13 and Murugeswari *et al*. (2022) in *celosia* fodder. Morais *et al*. (2020) reported that *cosmos* flowers has 55.71±1.16% and *clitoria* flowers has 30.93±2.75% antioxidant activity, which is consistent with current research findings.

CONCLUSION

The findings of this study indicated that selected edible flowers contains physiologically active and nutraceutical components that have important pharmacological and antioxidant properties. Among different annual flowers tested, the maximum ash content (15.58%), crude protein content (13.45%) and crude fibre content (13.39%) were found in *Gomphrena globosa* flowers, whereas maximum total carbohydrate content (21.20%) and total energy content (564.47 kcal/100 g) was reported in *Celosia argentea* var. Plumosa flowers. On other hand, the antioxidant activity was found to be superior in flowers of *Tagetes patula* (60.34%). The findings indicate that all eleven flower used in present experiment can strongly quench free radicals, reduce lipid peroxidation and maintain food aesthetics by chelating metal ions. This means that, depending on bioavailability of chemicals, the inclusion of flowers extract in diet could lessen the risk of numerous degenerative illnesses. In addition, the above selected flowers were the potential source of pigments, which is responsible for bright coloured inflorescences. The pigment has excellent antioxidant and anti-inflammatory capabilities, implying that it might be used on commercial scale to provide an essential food additive with promising health advantages. Future studies are required in order to find about nutritive/ antinutritive components of above-mentioned flowers.

Conflict of interest statement

We, the authors of this manuscript, declare that we don't have any financial or personal relationships with other people or organizations that could inappropriately influence our work. There are no conflicts of interest, including but not limited to patent applications/registrations, grants, consultancies, employment, or other funding.

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