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Studies on Preparation of *Sesbania grandiflora* Flower and Leaves Powder and Evaluation of its Physical, Functional and Reconstitutional properties

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ABSTRACT: *Sesbania grandiflora* is plant cultivated for its edible flowers in all over India. It's edible flowers and leaves has unique medicinal properties and used as a herbal drug for its antibiotic, anthelmintic and anti-tumor properties. The plant contains rich in phytochemicals such as polyphenols, flavonoids, carotenoids, tannins, steroids and triterpens having antioxidant, anticancer properties and used in colic disorder, jaundice, poisoning condition, small-pox, eruptive fever, epilepsy. *Sesbania grandiflora* flowers and leaves was underutilized vegetable because of seasonal availability and perishability. In present investigation efforts have taken to prepare powder from *S. grandiflora* flower and leaves to enhance its utilization. For preparation of powder flower and leaves subjected to different pre-treatments (without blanching, blanching and blanching + sulphitation). The effect of pre-treatment on drying characteristics flower and leaves was studied. Further effect of pre-treatment on physical, functional and reconstitutional properties of flower and leaves powder were investigated. The data obtained revealed that there is remarkable decrease in the drying time of blanched and blanched + sulphited flower and leaves. The results on colour attributes of flower and leaves powder show increase in lightness *i.e.* L* value and reduction in the a*and b* value in blanched + sulphited sample than control. In particle size analysis of powder the blanching + sulphitation treatment show the higher percentage on 80, 60 and 30 mesh sieve compared to other treatment. The data on functional properties of flower and leaves powder indicate that the highest bulk density, water absorption capacity, oil absorption capacity and swelling power was recorded in blanched sample FP_1 and LP_1. The treatment blanching + sulphitation show positive effect on solubility and wettability too. The findings of present investigation revealed that *Sesbania grandiflora* flower and leaves powder prepared by blanching + sulphitation treatment have better physical, functional and reconstitutional properties. The developed powder could be utilized in different value added product for fortification to improve its nutritional and phytochemical value.

Keywords: *Sesbania grandiflora,* medicinal properties, nutritional value, drying, physical, functional properties.

INTRODUCTION

Herbs and plants are the good source of antioxidants and they play a important role in combating generated free radicals. *Sesbania grandiflora* is plant cultivated for its edible flowers in all over India. It has synonym *Agati grandiflora* and commonly known as Hummingbird Tree, Butterfly Tree. It is small ornamental tree with a straight trunk produces white flowers like little birds. It is also cultivated in south or west India in the ganga valley and in Bengal. The plant contains rich in tanins, flavonoides, coumarins, steroids and triterpens. The plant used in colic disorder, jaundice, poisoning condition, small-pox, eruptive fever, epilepsy etc. (Suresh and Sanjay 2012). The literature on *Sesbania grandiflora* flower and leaves depict that they were good source of protein, ash, dietary fiber calcium, iron, phosphorus, Vitamin A, Niacin and vitamin C (Duke, 1983).

According previous studies of *S. grandiflora* exhibited the antioxidant activity and antiurolithiatic activity (Doddola *et al*., 2008), anticancer and chemopreventive activity (Laladhas *et al*., 2009). The whole plant is loaded with pharmacological activities and used for treating anemia, microbial infections, tuberculosis etc. The antioxidant property of Agati is due to the presence of phytochemical constituents making it a potent anticancer and hepatoprotective agent (Janani and Aruna 2017). *Sesbania grandiflora* as one of the rare tree where flowers and leaves can be eaten as vegetables, the nutrients of Sesbania leaves and pods are easily absorbed and no allergy has been reported (Noviany Hasan *et al.,* 2012).

Sesbania grandiflora flowers and leaves was underutilized vegetable because its available seasonally and highly perishable. Drying and dehydration is an ideal process to remove the moisture content thereby improve shelf life of the product. Dehydrated vegetables are equal to legumes in their protein content and become concentrated source of vitamins and minerals, and thus, they become a very suitable "natural fortificant". In present investigation considering the nutritional, medicinal and therapeutic importance and enhance the utilization of *Sesbania grandiflora* flowers and leaves, the process of preparation of powder from *S. grandiflora* flower and leaves was standardized. For preparation of powder flower and leaves were prepared and subjected to different pretreatment (without blanching, blanching and blanching + sulphitation). In this study, the effect of this pre-treatment on drying characteristics flower and leaves was studied. Further effect of these pre-treatment on physical, functional and reconstitutional properties of flower and leaves powder were investigated.

MATERIAL AND METHODS

A. Material

The raw material such as *Sesbania grandiflora* flower and leaves were procured from local market. For the preparation of powder *Sesbania grandiflora* flower and leaves were thoroughly washed. The calyx, stigma and spoiled petals were removed and petals of flower were separated. Similarly the leaves are separated from leaflet.

B. Preparation of Sesbania grandiflora flower and leaves powder

Pre-treatments. The prepared material for drying was subjected to different pre-treatment. The prepared material was separated into three lots. The first lot was kept unblanched, second was blanched. The third lot was subjected to blanching and sulphitation treatment. The hot water blanching method was used. Sulphitation was done by steeping raw material in 1 per cent potassium meta bisulphite (KMS) solution. The petals were kept in the solution for 5 min. and leaves for 10 min.

Drying. Cross flow cabinet drier was used for drying. The prepared raw material were spread on aluminium trays one kg material spread on each tray. The material were turned over every half an hour interval for uniform drying. The drying was carried out at 50-52^{o}C temperature. The weight was being measured at interval of 30 min until a constant weight was being recorded. The time required for drying of *Sesbania grandiflora* petals and leaves was recorded for each treatment.

Determination of dehydration ratio. Dehydration ratio was calculated by taking the ratio of weight of raw material (*Sesbania grandiflora* petals or leaves) entering drier (W_1) and coming out of the drier after dehydration (W_2).

Dehydration ratio = $W_1 : W_2$

Preparation of powder. The dried petals and leaves were finely ground in laboratory magnum mill, sieved and packed in 300 guage HDPE polythene bags. The yield of powder was calculated in percentage for each treatment.

C. Determination of physical, functional and reconstitution properties of Sesbania grandiflora flower and leave powder

Physical properties. The physical properties such as colour and particle Size distribution of flower and leaves powder were determined. Colour of *Sesbania grandiflora* flowers and leaves powder was measured by using Hunter lab colorimeter (Model No. Color Flex EZ) at the College of Horticulture, VNMKV, Parbhani. Hunter lab colorimeter measured the color in terms of the value L* (0 = black, 100 = white), a* (+value = red, -value=green) and b* (+value = yellow, -value = blue) with a standard white tile/board for setting the instrument with illuminate (Rajiv *et al.*, 2015). Particle size was determined by the procedure of Bodhankar (1992). The sample (100 g) was subjected to granulometry in analytical sieve shaker (equipped with 30, 60, 80, 100 and 120 mesh sieves). Sample 100 g was placed on top sieve, with the largest mesh and shaken for 20 min. The retained material on each sieve was weighed carefully and expressed as a percent of the original sample weight and calculated as retention value.

Functional properties. The functional properties such as bulk density, water absorption capacity, oil absorption capacity and swelling capacity of *Sesbania grandiflora* flower and leave powder was determined. Bulk density was determined by filling the sample gently in a container of known volume and weighed. The ratio between weight and volume was calculated as bulk density and expressed as g/ml. Water absorption capacity was calculated as the amount of water retained by 100 g of sample and expressed in per cent (Bodhankar, 1992). The capacity of oil absorption was calculated as illustrated by Sangnark and Noomhorm (2004) and represented as gram of oil per gram of powder retained. The swelling capacity calculated by

the method of Sowbhagya *et al*. (2007). Sample (1 g) was put in a graduated test tube and the marked volume (V_1) was set. 30 ml of distilled water was then introduced and the contents were dehydrated for 18 hrs. The final volume of the sample reached was measured (V_2). The outcome was represented as ml of swollen sample per gm of dry sample initial expressed in percentage.

Reconstitutional properties. The reconstitutional properties of *Sesbania grandiflora* flower and leaves powder was determined were solubility, dispersibility and wettability. The solubility was determined by method of Iyer and Singh (1997). One gram of powder was ground in a hand blender and combined with 100 ml of distilled water. The solution has been shifted to 50 ml centrifuge tubes and centrifuged for 5 min at 3000 rpm. It was permitted to settle for 30 minutes and shifted 25 ml of the supernatant to pre-weighed petri plates that were dried for 5 hr. at 105 °C. The solubility percentage was measured as the difference in weight of powder. Dispersibility will be measured by placing 10 g of sample in a 100 ml stoppered measuring cylinder adding distilled water to reach a volume of 100 ml. The volume of settled particles was subtracted from 100 and the difference reported as percentage dispersibility (Bodhankar, 1992). Wettability was measured using the process defined by Jinapong *et al*. (2008). Wettability is the period needed for 1 g of powder accumulated on the liquid surface to totally submerge at a temperature of 25°C in 400 mL distilled water.

RESULTS AND DISCUSSION

A. Effect of pre-treatment on drying characteristics of Sesbania grandiflora flower and leaves and it's powder yield

Data pertaining to Table 1 on the effect of pretreatments (without blanching, blanching and blanching + sulphitation) revealed there is remarkable decrease in the drying time of blanched and blanched + sulphited *Sesbania grandiflora* flower and leaves. The reduction in the drying time may be due to the effect of blanching which will open the compact cellular structure of fruit tissue that facilitates higher rate of heat transfer in the flower. Further it was reported that blanching of fruits and vegetable reduces the drying time (Thakur and Thakur 2000). The effect of sulphitation on the reduction of drying time was also reported by Chopra *et al*. (1989).

Table 1: Effect of pre-treatments on drying characteristic of *Sesbania grandiflora* flower and leaves and it's powder yield.

Treatment	Drying time(min)	dehydration Ratio	Yield (%)
Flower without blanching	260	10.51:1	8.25
Flower with blanching	230	11.19:1	7.10
Flower blanched + Sulphitation	200	12.40:1	6.25
Leaves without blanching	150	3.63:1	22.45
Leaves with blanching	120	4.25:1	19.04
Leaves blanched + Sulphitation	100	4.50:1	19.61

The results showed that the dehydration ratio of blanched + sulphited flower and leaves was found to be higher (12.40:1 and 4.50:1) followed by blanching of flower and leaves (11.19:1 and 4.25:1). It is observed from table that the yield of leaves powder is maximum compared to flower powder yield in all treatment, may be due to leaves contain less moisture and high edible index compared to flowers. Among pretreatment it observed that blanching, blanched + Sulphitation reduce the yield of powder both in flower and leaves. The treatment blanching, and blanching + sulphitation acceralates leaching lossess of solubles in soaked water and producing

B. Effect of different pre-treatments on physical properties of Sesbania grandiflora flower and leaves powder

The data on effect of different pre-treatments on physical properties such as colour and particle size distribution of *Sesbania grandiflora* flower and leaves powder was given below.

Effect of pre-treatments on colour characteristic of *Sesbania grandiflora* flower and leaves powder. A colour characteristic of raw material affects the colour of final product. Colour of *Sesbania grandiflora* flower and leaves powder is highly influenced by pretreatments. Table 2 explains the significant effect of pre-treatments on colour attributes of *Sesbania grandiflora* flower and leaves powder.

The L* value was for lightness, a* for redness-greenness and b* for yellowness-blueness. In case of flower powder the FP_2 showed highest value for L* (75.78) followed by FP_1 (70.20) and FP_0 (68.38). Similar trend of increase in lightness observed in case of leaves powder. Blanching treatment gave relatively higher whiteness due to inactivation of polyphenolase, which is responsible for browning reaction in flour (Akisso *et al.*, 2003). The sulphitation treatment was responsible for bleaching action on flower and leaves which results in to brighter colour of powder.

a* value was significantly reduced in treated sample than control both in flower and leaves powder. In flower powder reduction due to decrease in redness

colour and in leaves the degradation of chlorophyll content results in lowering a* value. The researcher Suriya *et al.* (2016) observed similar results for reduced a* value after blanching in yam flour.

The significant decrease in b* value of flower powder was noticed from FP_0 to FP_1 and FP_2. This might be due to blanching and sulphitation treatment, which gives lightness in yellow colour of flower powder. But in leaves powder different observation was seen for b* value that the decrease in LP_1 sample and increase in LP_2 sample than LP_0 was noticed. The sulphitation treatment might be responsible for increased b* value in LP_2 powder sample.

Table 2: Effect of pre-treatments on colour characteristic of *Sesbania grandiflora* flower and leaves powder.

Powder	L*	a*	b*
FP_0	68.38	6.99	32.52
FP_1	70.20	0.42	30.35
FP_2	75.78	0.28	28.10
LP_0	50.60	- 5.44	30.18
LP_1	53.89	-4.59	23.76
LP_2	56.32	-4.79	34.90
SE ±	0.0071	0.021	0.0042
CD at 5%	0.0213	0.063	0.0126

where,

FP_0 – Flower powder without blanching (control)
FP_1– Flower powder with blanching
FP_2 – Flower powder blanched + Sulphitation
LP_0 – Leaves powder without blanching (control)
LP_1– Leaves powder with blanching
LP_2 – Leaves powder blanched + Sulphitation

Effect of pre-treatments on particle size distribution of *Sesbania grandiflora* flower and leaves powder.

The data pertaining to particle size distribution of *Sesbania grandiflora* flower and leaves powder was presented in Table 14. The data revealed that highest yield of *Sesbania grandiflora* flower and leaves powder was recorded on 80 mesh sieve followed by 60 mesh sieve and 100 mesh sieve. The treatment blanched + sulphited received the higher percentage on 80, 60 and 30 mesh sieve having pore size 180, 250 and 300 µm pore size for flower and leaves powder compared to powder prepared by without treatment. The maximum flower powder retained 43.50 per cent and leaves powder 43.05 per cent on 80 mesh sieve. This may be the effect of less moisture content in blanched + sulphited powder which enables in grinding for yielding fine powder. It is observed that the higher the size of mesh, lower the particle size of the particles passed by the particular sieve.

The distribution of particle size varies with the pre-treatment, may be due to the different particle size, presence of moisture and process variable. Particle size is dependent on the cell or granule structure, type, and degree of processing, and chemical composition (Sahin and Sumnu 2006).

Table 3: Effect of pre-treatments on particle size distribution of *Sesbania grandiflora* flower powder and leaves powder

Particle size (mesh No.)	30	60	80	100	120
FP_0	6.90	35.70	41.50	12.10	3.80
FP_1	4.75	36.23	42.60	12.32	4.10
FP_2	2.00	37.10	43.50	12.90	4.50
LP_0	7.10	34.70	41.85	12.15	4.20
LP_1	4.50	35.45	42.40	13.32	4.33
LP_2	2.30	36.00	43.05	14.20	4.45
SE ±	0.033	0.441	0.502	0.064	0.046
CD at 5%	0.103	1.325	1.510	0.195	0.141

C. Effect of different pre-treatments on functional properties of Sesbania grandiflora flower and leaves powder

The results on effect of different pretreatments on functional properties of *Sesbania grandiflora* flower and leaves powder are depicted in Table 4. The highest bulk density recorded in sample FP_2 (0.476g/ml) and LP_2 (0.526g/ml). It is seen from table that the treatment blanching + sulphitation was found to be statistically significant over rest of treatment in both flower and leaves powder. The highest bulk density recorded in sample FP_2 (0.476g/ml) and LP_2 (0.526g/ml). High bulk density is a good physical attribute for determining mixing quality of particulate materials as flours with

low bulk density would mix well during dough preparation (Kinsella, 1987).

The maximum water absorption capacity was recorded in blanched sample FP_1 (285 %) and LP_1 (230 %) than untreated sample powder (FP_0 and LP_0). Unblanched samples absorbed less water compared to blanched samples may be the effect of blanching causes the elution of free sugars of low molecular weight. Free sugars such as sucrose and fructose absorb relatively less water than high molecular weight dietary fibres. Therefore, more high molecular weight dietary fibre existed per unit weight of dry matter in blanched samples, and consequently blanched samples were able to hold more water per unit weight. The researcher Akubor (2013) mentioned in their study on yam tuber drying that increased water absorption capacity of powder may be due to gelatinization of carbohydrates and swelling of fiber occurred during the blanching. Due to heat the major proteins disassociates into subunits with more water binding sites than the native or oligomeric proteins (Onimawo and Akubor 2012). In case of sulphitation treatment also the potassium metabisulphite modified the proteins and starch which enhanced the water absorption capacity of the powder (240 % of flower and 190 % of leaves) compared to untreated sample. The similar findings on enhanced water absorption capacity of blanched yam flour (280%) than raw (107%) yam flour was recorded by Akubor (2017).

The ability of flours to absorb oil may help to improve mouthfeel, enhance flavour retention and facilitate binding of the structure. The oil absorption capacity of raw and blanched *Sesbania grandiflora* flower and leaves powder varied between 130 and 200 per cent. All the treated sample had improved oil absorption capacity over that of the untreated sample (control). The mechanism of oil absorption is known to be mainly due to the physical entrapment of oil by capillary action in the hydrophobic components of the proteins. Oil absorption capacity indicates the degree of hydrophobicity of a food system (Onimawo and Akubor 2012). The denaturation of protein due to heating during blanching might have masked the non-polar residues from the interior of the protein molecule (Kinsella, 1987). Mouthfeel and flavor retention in food products was improved by absorption of oil (Baljeet *et al.,* 2010).

Table 4: Effect of pre-treatments on physical and functional properties of *Sesbania grandiflora* flower powder and leaves powder.

Powder	Bulk Density(g/ml)	Water Absorption Capacity (%)	Oil Absorption Capacity (%)	Swelling Capacity (%)
FP_0	0.312	180	133	25
FP_1	0.434	285	200	29
FP_2	0.476	240	180	33
LP_0	0.390	150	100	20
LP_1	0.480	230	190	25
LP_2	0.526	190	130	31
SE ±	0.021	25.019	21.102	0.305
CD at 5%	0.064	76.010	63.454	1.056

The implication of the high water and oil absorption capacities is that the treated *Sesbania grandiflora* flower and leaves powder would be good functional ingredients in food systems such as confectionery products where oil and water absorption is of prime importance.

The swelling power of powder prepared by blanched + sulphited treatment FP_2 (33 %) and LP_2 (31%) was recorded significantly maximum from rest of sample. The swelling capacity is the measure of the starch ability to absorb water and swell, and also reflects the extent of associative forces in the starch granules. Swelling capacity (index) is considered a quality measure in some food products such as bakery products. It is an indication of the non-covalent bonding between the molecules of starch granules and also one of the factors of the α-amylose and amylopectin ratios (Iwe *et al*., 2016). The untreated sample shows low swelling power may be due to high protein than the blanched + sulphited sample.

D. Effect of different pretreatments on reconstitutional properties of Sesbania grandiflora flower and leaves powder

The data pertaining to reconstitutional properties of *Sesbania grandiflora* flower and leaves powder was given in Table 5. Flour solubility is the amount of the flour that dissolves into solution, usually with water as solvent. Flour solubility is one of the functional properties usually determined during the development and testing of a new flour or flour composite (Awuchi *et al*., 2019).

The solubility was recorded maximum in blanched + sulphited (FP_2 and LP_2) sample followed by only blanched (FP_1, LP_1) and without blanched (FP_0, LP_0) sample. However, the per cent dispersibility was significantly reduced in treated sample (FP_1, LP_1 and FP_2, LP_2) than without blanched (FP_0, LP_0) sample. The trend of increase in solubility and decrease in per cent dispersibility in blanched and blanched + sulphited powder may be due to formation of porus structure which will improve the water absorption capacity and

clump formation. Increase in swelling and solubility values of the samples therefore, can be attributed to the degree of structural disorganization and degradation due to hydrothermal treatment and drying process (Tan and Chinnaswamy 1993).

Table 5: Effect of pre-treatments on reconstitution properties of *Sesbania grandiflora* flower powder and leaves powder.

Powder	Solubility (%)	Dispersibility(%)	Wettability (sec)
FP_0	18	30	273
FP_1	22	28	260
FP_2	25	22	250
LP_0	16	33	282
LP_1	21	30	275
LP_2	23	24	260
SE ±	0.819	0.408	2.128
CD at 5%	2.460	1.250	6.454

The wettability of *Sesbania grandiflora* flower and leaves powder varied between 250 -282 seconds. The time of powder wettability significantly reduced in blanched + sulphited treatment followed by blanching treatment than control. In treated sample the reduction in time may be effect of reduced particle size of powder leads to more surface area to sink water faster.

CONCLUSION

Data on the effect of pretreatments (without blanching, blanching and blanching + sulphitation) on drying characteristic revealed there is remarkable decrease in the drying time of blanched and blanched + sulphited *Sesbania grandiflora* flower and leaves. Effect of pre-treatments on colour attributes of *Sesbania grandiflora* flower and leaves powder show increase in lightness *i.e.* L* value and reduction in the a*and b* value in treated sample which imparts attractive brightness to powder. The powder prepared by blanching + sulphitation treatment received the higher percentage on 80, 60 and 30 mesh sieve having pore size 180, 250 and 300 µm pore size. The maximum flower powder retained 43.50 per cent and leaves powder 43.05 per cent on 80 mesh sieve. The pre-treatments blanching + sulphitation results in to improvement in functional as well as reconstitutional properties of *Sesbania grandiflora* flower and leaves powder. It can be concluded from present investigation that the treatment blanching + sulphitation was suitable for both *Sesbania grandiflora* flower and leaves powder preparation. As per earlier studies reported *Sesbania grandiflora* flower and leaves had nutritional, medicinal and therapeutic significance hence the developed flower and leaves powder would be utilized in different value added products for improving its nutritional and functional value.

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Conflict of Interest. None.

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