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Effect of different blanching Pre-tretment and drying methods on quality of Pea pods powder

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Abstract
The aim of this study is to utilize the vegetable by-product for value addition in food. In this study, pea pod powder is developed using different pre-treatments of blanching and drying methods. Pea pods were subjected to different pre-treatments such as citric acid blanching (CB), potassium metabisulphite dipping (KMS) and hot water blanching (HB). A control or untreated sample (UT) was kept for comparing with treated sample. Pre-treated samples were dried using different drying techniques i.e. convective tray drying (55°C, 65°C and 75 °C), sun drying and solar drying. The dried samples were evaluated for its moisture content, drying time, crude fibre content, lignin content and colour attributes. The result of the study showed significant effect ($p< 0.005$) of blanching and dying on the quality of pea pods. The lignin content was minimum for control (UT) sample and crude fibre content was higher for UT samples convectively dried at 75 °C whereas maximum rehydration ratio was observed in convectively dried KMS pre-treated samples at 75 °C. Overall, the UT samples followed by 75 °C convective drying was found to be the best combination for retaining quality attributes of pea pods.

Keywords: Vegetable waste, pea pods, blanching pre-treatments, drying, quality

Introduction

Pea (*Pisumsativum* L.) is the small spherical seed which belongs to the fabaceae family also known as legume family. Fresh pea contains protein (25%), amino acids (12%), carbohydrates (16%), vitamin A & C, calcium, phosphorous & small quantity of iron. Pea contains only 30-40% seed and 60-70% portion as pods which go as wastage. Pea pods content and nutritional values are unexploded but it consumed as raw in some places and they contain a waxy layer known as parchment layer, which is not consumable and irritates consumer. Besides rich in nutritional values, majority of pea pods goes as wastage and only small portion is used as a feed for animals. Thus a promising way is to pre-treat, dry and store the pea pods in powder form and utilize as a substitute of base materials for developing nutritionally rich food products.

Drying technique for the preservation of food products is one of the oldest techniques. Drying or dehydration is used to increase the shelf life of perishable food for further use (Roberts *et al.* 2008) [21]. By drying foods, the flavor and most of the nutritional value is preserved and concentrated (Dennis 1999) [8]. Dried pea pods can be used to develop extruded snacks. Dehydration of pea pods in mechanical dryers, solar dryers, or by air drying with direct sun exposure are alternatives for long term cold storage or canning. Pretreatments and methods of dehydration influence dried product quality (Kulkarni *et al.* 1994; Waghmore *et al.* 1999; Krokida and Maroulis 2001; Alam *et al.* 2013) [13, 23, 12, 1]. Quality of dried pea pods can be improved by pretreatments such as blanching. Blanching is mainly performed to neutralize enzymes i.e. polyphenoloxidases, catalase, peroxidase and phenolase. Neutralization of enzyme reduces rate of deterioration i.e. flavor, texture and colour changes in the product (Arroqui *et al.* 2003; Mazza 1983; Prakash *et al.* 2004; Severini *et al.* 2005) [2, 16, 20, 22]. Blanching can be conducted by different methods such as dipping in hot or boiling solutions containing acids and/or salts, hot water (the most common method), or steam, (Kidmose and Martens 1999) [10] for few seconds or minutes. Fresh pea pods, if properly dried, packaged and stored, may increase availability for utilization in fiber rich products.

Thus, the present study was undertaken to select suitable blanching pre-treatments and drying methods for production of pea pods powder and to assess their effect on quality of dried pea pods powder.

Materials and Methods

Sample preparation: Peas were procured from local market of Ludhiana, Punjab during December and were washed with running tap water to remove impurities prior to blanching pretreatment. Then wiped with muslin cloth and the seed and pea pods were separated for further use of pea pods.

Blanching pretreatments: Pea pods were subjected to different blanching pretreatments. The blanching time of pea pods were standardized by performing the peroxidase test. Blanching time of 15 minutes at 95°C was found to be optimum. Pea pods were given hot water blanching (HB), 1% (w/v) citric acid blanching (CB) and 6% potassium metabisulphite (KMS) dipping. No blanching was given to the control (raw) sample and was expressed as untreated sample (UT).

Drying Methods: Three drying methods were used for the development of dried pea pods *viz*. convective drying, sun drying and solar drying. For each drying technique initial weight of sample was 200g. The samples were dried up to their equilibrium moisture content (EMC).

Convective drying: Convective drying was done at constant temperature of 55ºC, 65ºC and 75ºC in a tray dryer of dimensions 1.37cm × 0.94cm × 0.43 cm. The pea pods to be dried was spread on the pre-fabricated trays (27.94cm × 21.59 cm) with drying bed thickness of 4 mm. Weight was measured at regular intervals.

Sun Drying*:* For sun drying, the pea pods samples were spread uniformly on the trays (75.5cm × 45.2 cm × 2.5 cm) covered with net sheet and exposed to open sun. Weight of each samples were recorded at regular intervals using electronic weighing balance. The temperature and relative humidity of ambient air and drying air during sun drying and solar drying were recorded throughout the drying process with the help of digital hygrometer.

Solar Drying*:* For solar drying, a batch type tray dryer of 40 kg capacity was used. The material used for construction was pre-coated MI sheet for outer surface and angle iron and steel was used on inner sides. In this dryer two sets of 8 trays (75.5 cm × 45.2 cm × 2.5 cm, 2.56 kg) are provided which are constructed with wire mesh of food grade stainless steel (SS 304) was used. The heated air entered the chamber from below which was trapezoidal in shape for gradual spreading of the heated air evenly into the drying chamber. The opening for exhaust was provided at the back of drying chamber. All the outer sides and roof of the drying chamber was lined with expanded polystyrene (0.0254 m thickness). The door of the chamber was lined on the inside to make it leak proof.

Quality attributes: The dried pea pods samples were ground to powder in a Mixer-cum-Grinder (Make: Sujata 750 W) and were kept in sealed polybags for further quality analysis. The developed powder samples were then evaluated for their physico-chemical quality attributes. Quality parameters namely colour, crude fiber, lignin content, EMC and drying time were estimated. The colour and crude fiber were determined by the procedure as given below.

Colour measurement: The colour property of samples was measured by using Colour Reader CR-10 (Konica Minolta Sensing Inc.).The colour values 'L', 'a' and 'b' were measured at D 65/10°. For determination of colour, the samples were ground to powder using pestle mortar. The powder was completely filled in petri dish provided that no light was allowed to pass during the measuring process. The colour change, chroma and hue angle was calculated by the equation given below (Gnanasekharan *et al.* 1992).

$$\text{Colour change} = [(L-L_o)^2 + (a-a_o)^2 + (b-b_o)^2]^{1/2}$$
$$\text{Chroma} = (a^2 + b^2)^{1/2}$$
$$\text{Hue angle} = \tan^{-1}(b/a)$$

Where; L_o, a_o, b_o and L, a, b represent the readings of untreated pea pods and dried pea pods respectively.

Crude fiber: Crude fiber of pea pods powder was estimated using Fibertec (Foss instrument, Sweden). Capsules (for holding the sample) were kept in hot air oven at 100°C for 20 minutes for drying, cooled and weighed. One gram of the sample was weighed in the capsule. Capsules were fixed in the rotating stand and put in the extraction cup; 250 - 275 ml of 1.25% H_2SO_4 solution was added to the extraction cup and the stand was immersed into the beaker. Acid extraction was done by boiling it for 30-40 minutes followed by washing with hot water. Then alkali washing was done with 1.25% NaOH for the same time duration followed by hot water washing. Finally, capsules were dried in oven (Universal, Model NSW143) for 2 hours at 130°C and then placed in autoclave at 550 °C for 5 hours, cooled and weighed for crude fiber estimation (AOAC 2000) [3, 4].

Lignin Content: Lignin content of pea pods was estimated according to AOAC 2000 [3, 4] methodology (Nasar-Abbas *et al*. 2008). Already prepared acid detergent fiber residue mat was covered with cold solution of 72% H_2SO_4 (w/w). Filled the crucible about half way with acid and stirred with a rod. The lumps were broken with a glass rod and the glass rod was left in the crucible. The crucible was refilled with 72% H_2SO_4 and was stirred as the acid drains. After 3 hours, suction was applied to wash the contents of the crucible with hot distilled water to neutral pH water. The crucible was heated at 100°C in hot air oven. It was cooled in desiccators and was weighed. The above crucible was ignited at 550°C in muffle furnace for 2 h. The crucible while still hot was placed in oven at 100°C for 1 h after removing it from furnace. The crucible was cooled in a dessicator and was weighed.

$$\text{Lignin\%} = W_3\text{-}W_2/S \times 100$$

Where, W_3= loss in weight on ignition after 72% H_2SO_4 treatment
W_2= weight of 72% H_2SO_4 treated crucible
S= weight of dry sample

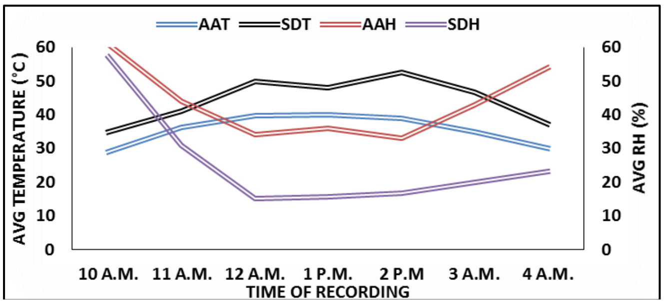
Statistical analysis: Each experiment was replicated twice. All the results were statistically analysed to estimate the significant difference between treatments and drying methods on the basis of physico-chemical quality attributes. The analysis was done using ANOVA technique using CPCS1 computer software package (Cheema and Singh 1990) [6].

Means were computed and the least significant difference (LSD) was calculated at 5% level of significance ($p \leq 0.05$).

Results and Discussion

Drying time and equilibrium moisture content (EMC): The drying time required by different drying methods along with their EMC is presented in Table 1. Drying time was significantly ($p \leq 0.05$) effected by the drying method (Table 2). The samples dried under convective drying (180-430 min) witnessed comparatively lesser drying time than sun drying 660 min and solar drying (360-390 min). This can be related to the fact that drying at higher temperatures provides larger driving forces for heat transfer, which increases the drying rate. Furthermore, the moisture diffusivity is also higher at a higher drying temperature (Leeratanarak *et al.* 2006) [14]. After sun drying of pea pods to EMC, grinding of pea pods was not possible due to high EMC (>15%), therefore sun dried samples were further subjected toconvective drying at 65^{0}C and pea pods powder was made for further analysis. The final moisture content to which the pea pods dried under sun drying and solar drying varied from 4.01% and 11.6% db (Table 1). Pre-treatments and drying methods and their interaction significantly ($p \leq 0.05$) affected EMC (Table 2). The final moisture content in case of convective drying was 1.25% to 4.07% (db). EMC at 75^{0}C and 65^{0}C were nearly similar and minimum. Effect of drying method was significant ($p \leq 0.05$) as compared to blanching pre-treatments (Table 2).

During sun drying, the average air temperature (AAT) and average relative humidity (AAH) ranged between 28.9°C to 40.1°C and 33% to 61% respectively whereas, within solar dryer, the relative humidity (SDH) and temperature (SDT) varied between 15.2% to 57% and 35°C to 52.5°C respectively throughout drying process (Fig 1).



(AAT = Ambient air temperature, AAH = Ambient air relative humidity, SDT = Solar drying temperature, SDH = Solar drying relative humidity)

Fig 1: Variation in average temperature and average humidity measured during drying

Rehydration Ratio: The results for different experimental combinations of blanching pre-treatments and drying methods on rehydration ratio are given in Table 1. The rehydration ratio was higher in case of KMS treated samples convectively dried at 75^0 C. Rehydration ratio varies from 3.18 to 5.81. Table 4.2b shows that the effect of drying method and blanching method on rehydration ratio was significant ($p \leq 0.05$). Similar results are also found in drumstick leaves (Satwase *et al.* 2013).

Crude Fibre: The results for different experimental combinations of blanching pre-treatments and drying methods on fibre content are given in Table 1. The crude fibre content was higher in case of CB samples convectively dried at 75^0 C. Table 2 shows that the effect of combination of drying methods and blanching pre-treatments on crude fibre content was significant ($p \leq 0.05$). It varied from 18.76% to 26.77%. Moreover, the blanching pre-treatment increased the crude fibre content of dried sample compared with UT dried sample. This is probably due to the loosing of small molecule such as minerals, vitamins and sugar to blanching water hence varying in the total solid content of sample and resulted in a relatively increase of other dry matter (Wennberg *et al.* 2004) [25]. Similar results were also found in mosambipomace (Kirandeep *et al.* 2016) [11], cabbage outer leaves (Nilnakara*et al.* 2009) and White cabbage (Wennberg*et al.* 2006) [24].

Table 1: Effect of blanching pre-treatment and drying methods on quality of pea pods

Drying method	Blanching pre-treatment	Drying time (min)	EMC (%)	Rehydration ratio	Crude fibre (%)
CD (55°C)	UT	430	4.07	4.38	18.76
	HB	390	2.61	4.68	21.61
	CB	370	2.76	4.03	23.13
	KMS	375	2.90	5.21	23.39
CD (65°C)	UT	315	2.18	4.51	20.11
	HB	290	1.62	4.72	23.58
	CB	240	2.29	4.00	23.81
	KMS	240	1.72	4.95	23.19
CD (75°C)	UT	230	2.98	4.76	20.36
	HB	195	1.25	5.01	24.23
	CB	180	1.78	4.51	26.77
	KMS	180	1.94	5.81	26.34
Sun	UT	660	11.6	3.16	18.39
	HB	660	10.78	3.83	21.36
	CB	660	10.10	3.18	23.09
	KMS	660	11.6	3.92	22.76
Solar	UT	390	5.50	4.19	19.78
	HB	360	3.98	4.51	22.67
	CB	360	4.01	3.98	24.61
	KMS	360	3.77	5.12	23.98

Note: C D = Convective drying, UT = untreated sample, HB = Hot water blanched sample, CB = citric acid blanched, KMS = potassium metabisulphite dipping

Table 2: Analysis of variance for effect of blanching pre-treatment and drying methods on quality parameters of pea pods

Quality parameters	Blanching pre-treatment (A)				Drying method(B)				
	HB	CB	KMS	UT	Sun	Solar	CD(55°C)	CD(65°C)	CD(75°C)
Drying time	379	362	363	405	660	367.5	391.25	271.25	196.25
LSD (p≤0.05)		A: 0.74			B:0.66			AB: 0.146	
C.V. (%)		1.87							
EMC (%)	4.05	4.18	4.39	5.27	5.64	3.73	3.40	3.27	3.18
LSD (p≤0.05)		A:0.015			B:0.013			AB:0.029	
C.V. (%)		0.31							
RR	4.55	3.94	5.00	4.20	3.52	4.45	4.58	4.55	5.02
LSD (p≤0.05)		A:0.133			B:0.118			AB:0.264	
C.V. (%)		2.86							
Crude fibre	22.69	24.3	23.93	19.48	21.40	22.76	21.72	22.67	24.43
LSD (p≤0.05)		A:0.144			B:0.129			AB:.288	
C.V. (%)		0.61							
'L' Value	66.56	65	69.3	70.46	69.90	65.88	68.15	69.20	66.03
LSD (p≤0.05)		A:0.041			B:0.037			AB:0.082	
C.V. (%)		0.06							
'a' Value	-6.56	-3.22	-5.32	-8.78	-3.40	-6.20	-7.40	-6.95	-5.90
LSD (p≤0.05)		A: 0.000003			B: 0.00003			AB:0.000007	
C.V. (%)		0.00							
'b' Value	23.16	22.9	23.80	25.88	23.65	23.25	25.23	24.50	23.03
LSD (p≤0.05)		A:0.0103			B: 0.09217			AB:0.02061	
C.V. (%)		0.04							
Color change	19.53	18.8	22.36	23.70	23.52	18.98	21.66	22.30	18.99
LSD (p≤0.05)		A: 0.010305			B: 0.09217			AB:0.02061	
C.V. (%)		0.05							
Chroma	74.57	81.8	74.57	71.40	82.24	75.43	73.86	74.39	75.66
LSD (p≤0.05)		A:0.051			B:0.045			AB:0.101	
C.V. (%)		0.06							
Hue angle	24.18	23.1	24.44	27.40	24.01	24.12	26.47	25.55	23.80
LSD (p≤0.05)		A:0.000003			B:0.000003			AB:0.000007	
C.V. (%)		0.00							

Note: C D = Convective drying, UT = untreated sample, HB = Hot water blanched sample, CB = citric acid blanched, KMS = potassium metabisulphite dipping, RR= Rehydration ratio

Lignin content: Lignin content of peapod was not affected by different drying method and pre-treatments. Lignin is not suitable for human consumption due to its indigestible nature, therefore for using pea pods powder as a fibre enhancer in food products its lignin content should be less. Sieve analysis of pea pod samples was performed and material retain on each sieve was further analysed for lignin content. Final selection of pea pods powder fraction for further use in food product should be done on the basis of its lignin content.

Table 3: Sieve analysis for pea pod

Sieve size (Tyler Mesh No.)	Particle Size (mm)	Blanching pre-treatments						Untreated	
		HB		CB		KMS		UT	
		Fraction Wt (%)	LC (%)	Fraction Wt (%)	LC (%)	Fraction Wt (%)	LC (%)	Fraction Wt (%)	LC (%)
31/2	5.6	-	-	-	-	-	-	-	-
7	2.8	-	-	-	-	-	-	-	-
12	1.4	-	-	-	-	-	-	-	-
24	0.71	-	-	-	-	-	-	5.98	9.65
42	0.355	26.10	7.7	11.67	5.66	15.15	5.55	29.31	6.8
80	0.180	68.98	5.5	58.67	5.75	60.23	5.65	53.63	2.5
-	Pan	4.92	2.1	29.66	4.2	24.62	4.4	11..08	0.9

Colour attributes: For measuring colour change values of "L", "a", and "b" were measured. Chroma value and Hue angle were calculated. The Maximum colour change was observed in convectively dried UT samples at (55°C). The initial colour 'L', 'a' and 'b' values of non-blanched radish leaves (the reference raw sample) were 48.1, -9.8 and 18.5 respectively. Pea pods became slightly lighter, corresponding increase in 'L' value. Blanching enhanced the colour of radish leaves resulting in decrease in 'b' value and increase in 'a' value making it light greenish irrespective of the drying method used.

'L' value: Pre-treatment and drying method affected 'L' values. The highest 'L' value (74.5) was for UT samples convectively dried (55°C); the lowest value (67) was for CB samples convectively dried (75°C) (Table 4). Solar drying produced the highest average 'L' values compared to other drying methods. The 'L' value was affected by interaction of pre-treatments and drying methods. The statistical analysis revealed that the impact of drying methods was significantly (p≤0.05) higher on 'L' value as compared to pre-treatments (Table 2).

'a' value: According to experimental data, the highest 'a' value (-1.4) was recorded for CB treated convective (55°C) dried sample. On the other hand, the minimum 'a' value (-10.9) was recorded for UT convective (55°C) dried sample (Table 4). Better colour retention was observed in samples

convectively dried at 75°C irrespective of the blanching pre-treatments. Table 2 shows that 'a' value was significantly (p≤0.05) affected by drying method and combination of drying method and blanching pre-treatments.

'b' value: The maximum 'b' value (26.30) was recorded for UT sample convectively dried (65°C), whereas, the minimum 'b' value (20.5) was observed for CB pre-treated solar dried samples (Table 4). There was significant (p≤0.05) effect of drying methods as compared to blanching pre-treatment on 'b' value (Table 2).

Color change, chroma and hue angle: Colour change was affected by pre-treatment and drying method individually and in combination. Drying method affected chroma and hue angle. The chroma and hue angles were affected significantly (p≤0.05) by the interaction of pretreatment and drying method (Table 2). The highest colour change (ΔE) (27.28) was for UT convectively (55°C) dried samples; the minimum colour change (15.42) was for CB pre-treated samples convectively dried at 75°C (Table 4.4b). Interaction of pre-treatments and drying methods significantly (p≤0.05) affected colour change (Table 2). For chroma the highest value (86.56) was for CB pre-treated sun dried samples; the minimum value was 66.69 for UT samples convectively dried at 55°C. The hue angle was highest (28.96) for 65°C convectively dried UT samples and was lowest (21.28) for sun dried CB pre-treated convectively dried (75°C) samples.

Table 4: Effect of blanching pre-treatments and drying methods on colour attributes of pea pods

Drying Method	Blanching Pre-treatment	Colour attributes					
		'L' value	'a' value	'b' value	Colour change	Chroma	Hue angle
Sun	UT	70	-8	26.2	23.28	73.02	27.39
	CB	69.5	-1.4	23.3	23.49	86.56	23.34
	KMS	71.2	-2.3	23.8	24.86	84.48	23.91
	HB	68.9	-1.9	21.3	22.43	84.90	21.39
Solar	UT	67.1	-9.8	25.9	20.39	69.27	27.69
	CB	62.9	-3.9	20.5	16.06	79.23	20.87
	KMS	68.1	-4.8	23.3	21.17	78.36	23.79
	HB	65.4	-6.3	23.3	18.29	74.87	24.14
C D (55°C)	UT	74.5	-10.9	25.3	27.28	66.69	27.55
	CB	63.5	-2.7	25.7	18.42	84.00	25.84
	KMS	70.3	-6.1	24.4	23.27	75.96	25.15
	HB	64.3	-9.9	25.5	17.65	68.78	27.35
C D (65°C)	UT	72.8	-10.2	27.1	26.16	69.38	28.96
	CB	66.7	-3.6	24.1	20.39	81..50	24.37
	KMS	69.9	-6.9	24	22.67	73.96	24.97
	HB	67.4	-7.1	22.8	19.96	72.70	23.88
C D (75°C)	UT	67.9	-5	24.9	21.36	78.65	25.40
	CB	62.4	-4.5	20.8	15.42	77.79	21.28
	KMS	67	-6.5	23.5	19.83	74.54	24.38
	HB	66.8	-7.6	22.9	19.34	71.64	24.13

Note: C D = Convective drying, UT = untreated sample, HB = Hot water blanched sample, CB = citric acid blanched, KMS = potassium metabisulphite dipping

The UT (untreated) sample of pea pods when convectively dried at 75^0 C was adjudged as best combination for retaining quality attributes on the basis of lignin content, minimum lignin content (0.9) was found in pan after the sieve analysis of this sample and maximum (9.65) was found in 0.71 mm size sieve. Overall, the convectively dried(75°C) UT peapod sample was adjudged as best combination for retaining quality attributes. So the powder prepared using UT treated sample having particle size in range 0.355-0.180mmrecording minimum lignin content.

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