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# Studies on efficient rehydration of dried green peas (*Pisum sativum*)

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■ **Abstract :** This study investigates efficient rehydration of dried green peas for its use in "Heat and Eat" food products. Dehydration and rehydration kinetics of green peas were studied on Hot Air Dryer (HAD) and Solar Conduction Dryer (SCD) for untreated and pre-treated samples. The two pre-treatments used were 1. Partial cuts on the surface, followed by steaming for 2 mins and 2.Blanching in 1% $Na_2CO_3$ solution for 2 mins. Rehydration was carried out under conditions of varying temperature (50, 70 and 90 °C) and time (5 and 10 mins). Hardness, Rehydration Ratio and Colour (L*a*b* values) was measured for fresh, dried and rehydrated samples to find the optimum pre-treatment and drying method for efficient rehydration. Partial surface cuts followed by steaming was found to be the better pre-treatment for both HAD and SCD dried peas whereas colour after rehydration was better retained in HAD dried peas."

■ **Key words :** Rehydration, Dried peas, $Na_2CO_3$

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Green peas (*Pisum sativum*) is an important legume plant and is the second largest cultivated grain legume which belongs to leguminous family. It is perishable as well as seasonal in nature. It contains about 78% moisture. India is the second largest producer of vegetables, next only to China, in the world with a production of 40 million tonnes from four million hectares of land area. It originated in the Middle East and was later widely grown in temperate regions of the world, among them China, India, United States, France and Egypt are its major producers. Pea seeds consist of 23-25% of protein, 50% starch, 5% soluble sugars including fibre, minerals, vitamins and phytochemicals in minor quantities. Peas are high in fibre and low in fat and contain no cholesterol (An*et al.*, 2010). They are a good source of vegetable protein. This green legume is loaded with A, B-1, B-6, C, and a supersized serving of osteoporosis-fighting K. The minerals and vitamins offer disease prevention whereas the pea cell wall cotyledons and the seed coat contain fibres which help in better gastrointestinal activity . Due to their seasonal availability and perishable nature, it is necessary to preserve the green peas using suitable preservation techniques such as freezing, canning, or drying. so drying of peas is becoming a preferred method to extend its shelf life and consumability (Ismail *et al.*, 2014 and Jadhav *et al.*, 2010).

Like any other green vegetable, green peas are available for around 4-5 months only. In view of their demand round the year, they can be preserved with the help of dehydration process and sold during off-season. It is also possible to produce powder which has got good market prospects. But this note considers only dehydration of green peas. They are used for making vegetables, as additives in certain vegetables and for making several snack preparations. Hence, if they are made available even during off-season, there is a good market for them.

There are several processed product available throughout the year like frozen peas and canned peas, but they cannot be used in the preparation of soup powder and traditional Indian snacks because they are very expensive. The dehydrated green peas due to its cost effectiveness and better sensory characteristics is getting acceptance in the market compared to other form of processed peas.

Drying is an essential process used all over the world for the preservation of farm produce. It converts solid, semisolid or liquid into solid products by evaporation with the means of thermal energy. It is also used for the preservation and storage of food products. Dried products are easy to handle, reduction in cost of transport and desired quality. It helps in reducing the water activity of the produce to a level below which deterioration does not occur for a definite duration. It reduces microbial activity on the product (Chauhan and Srivastava, 2009). Various drying methods/sources are employed to dry different food produce. Appropriate use of these sources in drying provide reduction of drying time and specific improvement of the product quality in terms of colour, taste and texture (Prasad *et al.*, 2006).

The main objective of present study is

– To determine the efficient rehydration of dried green peas in a short time to be incorporated into ready-to-eat food products.

– To determine the effect of pre-treatment before drying.

– To determine the drying kinetics of green peas.

– To determine rehydration kinetics, hardness and color of dried green peas.

## METHODOLOGY

### Materials :

Fresh green peas (*Pisum sativum*) were purchased from a local market. Damaged, immature, and dry pods were removed manually by visual inspection. The pea pods were shelled manually. The average diameter of the green peas was 0.8- 0.1 cm. The initial moisture content of green peas was determined by moister meter at 105-110$^0$C (Shukla *et al.,* 2014 and Wange *et al.*, 2007). The average initial moisture content was found to be 76% on wet basis. In the previous work by Senadeera (2004), an initial moisture of 75-80% on wet basis for this agro product was reported.

### Drying experiments :

Drying experiments were performed on hot air dryer and solar conduction dryer. Pre-treatments were applied to the peas before drying, and an untreated sample was used as a control (Kanwade and Narain, 1990; Sobukola, 2009 and Srivastava and Sulebele, 1975). Details of each treatment are described in Table A. After pre-treatment, samples were placed on perforated stainless steel.

**Table A : Pretreatment methods**

| Code | Description |
|---|---|
| Control | Untreated samples |
| Partial cut | Partial cuts on the surface, followed by steaming for 2 min |
| 1 % $Na_2CO_3$ | Blanching in 1% $Na_2CO_3$ solution for 2 min |

Moisture content of samples was recorded using Contech moisture analyzer at a regular interval of time. Temperature of air in the dryer and weight of the samples were also monitored at preset time interval. As per dryer specification, drying was stopped when the moisture content of the samples reached to 5–6% (wb) for both types (Krishna Murthy *et al.*, 2014).

### Drying apparatus :

*Hot air dryer :*

The laboratory hot dryer (M/s S.B. Panchal And

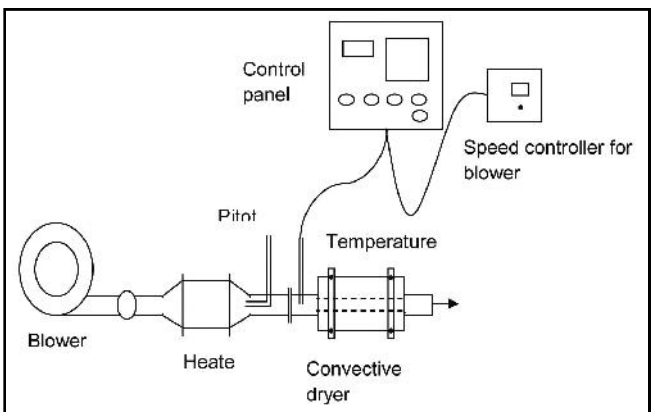


**Fig. A : Typical setup of HAD**

Company, Mumbai, India) used in the present study was equipped with several supporting features such as blower, speed regulator, temperature controller, heaters humidity sensing device and pitot tube to measure the air velocity. the relative humidity and temperature of the ambient air were in the range 60-65% and 30°C, respectively. green peas were taken in tray which was kept on a perforated tray and drying was carried out at 60°C with 20 rpm. The typical setup of HAD is shown in Fig. A.

**Solar conduction dryer :**

The Solar conduction dryer is a solar powered food dehydrator (Fig. B) developed by a group of innovators known as Science for Society (S4S). The device utilizes solar power in a conductive manner as well as convective way for drying. The structure of solar conductive dryer which comprises of four drying chambers constructed from hollow sections of stainless steel. The dryer has four drying trays, covering a surface area of 1.04 $m^2$ each. Transparent plastic (PC Multiwall Sheet) is used to cover the trays. The trays are coated with black color special food grade coating, where the products to be dried are placed. A low height air vent to create air current is provided at the middle of the dryer along horizontal direction which also separates the drying chambers in two parts. Each portion contains two drying trays. Atmospheric air enters from the front of the trays and it carries away the moisture of the sample through the chimney. Accesses to the trays are done by sliding the trays out in a designed channel for loading purpose. Engineering drawing of solar conductive dryer is given in Fig. C.

**Fig. B : Solar conduction dryer**

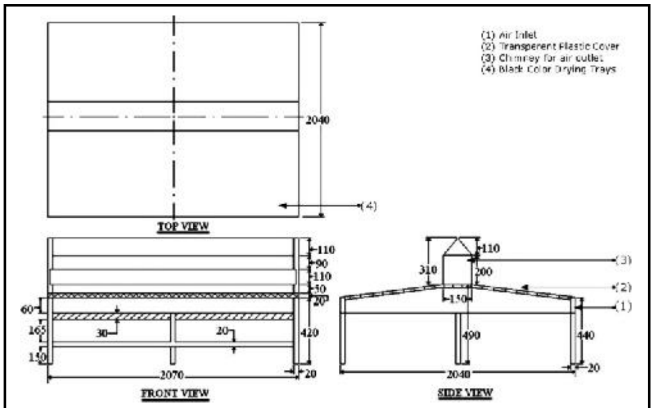


**Fig. C : Engineering drawing of SCD (all dim. in mm)**

**Instrumentation and observation :**

J-type thermocouple (–210 °C to 750 °C) and velocity transmitter (Make-Kimo Instrument, France) were used for measuring temperatures and air velocity at different places, respectively. All the measuring instruments were logged into a 16-channnel data logger (Make-R.S. Process System Pvt. Ltd., India). Temperatures and velocities probes were kept at the air inlet of the dryer as well as at the outlet vent of the chimney. Thermocouples were also installed in each tray during drying period. Solar radiation data was obtained.

**Data analysis :**

*Drying kinetics:*

Drying of green peas were observed to be in falling rate. The moisture diffusion of peas can be generalized for moisture ratio (*MR*) expression, which is given as:

$$MR = \frac{M_t - Me}{Mo - Me}$$

where, $M$ is the material moisture content in % (wb) at time '*t*', $M_e$ is the equilibrium moisture content % (wb) of the material and $M_0$ is the initial moisture content of the material % (wb). The drying curves are filted by means of two moisture ratio models that are widely used in most food and biological materials (Simal *et al.*, 1996).

**Rehydration kinetics of dehydrated green peas:**

Rehydration kinetics study was carried out under conditions of varying temperature (50°C,$70^0$Cand $90^0$C) and time (5 and 10 mins). The beakers containing water and dried green peas were kept in hot plate(REMI-10 MLH PLUS) pre-set at 50°C. The approximate ratio of dried green peas and water volume was kept as 1:20.

The sample was withdrawn from the liquid every 2 min, and excess water was carefully removed by blotting on a tissue paper, before weighing. The actual rehydration duration was 100 min. Weights of dried and rehydrated samples were measured using an electronic digital balance (Precisa, model BJ4100D, Precisa Instruments AG, Dietikon, Switzerland) having a sensitivity of 0.001 g. T. The change in weight and volume were recorded after a regular interval of time. Then the rehydrated samples were put in moisture balance (MOC-120H)for determination of water gain and solid loss.

The rehydration ratio was computed by using the equation

$$\text{Rehydration ratio} = \frac{\text{Weight of rehydrated green peas (g)}}{\text{Weight of dehydrated green peas}}$$

**Colour:**

The fresh, dried and rehydrated green peas samples were assessed for their colour using chromameter (Konica Minolta CR-400, Osaka, Japan) with a measuring area of 8 mm diameter. Samples were scanned at ten different locations to determine the average L*, a*, b* values as the average of the ten measurements.

Measurement was done in three replications. Out of five colour systems given by Chromameter, the Hunter system, also known as L*, a*, b* system was selected, because this is the most used system for evaluation of dried food material. In this system, “L” is the brightness ranging from no reflection for black (L=0) to prefect diffuse reflection for white (L=100). The value “a” is the redness, ranging from negative value for green to positive values for red. The value “b” is the yellowness, ranging from negative values for blue and positive values for yellow. Color measures the total color change parameter ($\Delta E$) is also calculated in this literature (Singh *et al*., 2006).

**Total colorchange(aE) :**

$$\Delta L^* = L^*_{Sample} - L^*_{Standard}$$

$$\Delta a^* = a^*_{Sample} - a^*_{Standard}$$

$$\Delta b^* = b^*_{Sample} - b^*_{Standard}$$

$$\Delta E = \sqrt{\left(\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}\right)}$$

**Hardness :**

Hardness is the maximum peak force during first compression cycle (first bite) and it can be measured in grams. The fresh, dried and rehydrated green peas samples were assessed for their hardness using Brookfield Ct3 Texture Analyzer with a load cell of 50 gm. Hardness of dried and rehydrated green peas were calculated from force/deformation profiles. At least, 5 measurements were performed for each set of samples.

## RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

**Drying kinetics of green peas dehydrated on HAD and SCD dryer :**

As illustrated in Fig. 1 HAD cuts and steamed and HAD $Na_2CO_3$ treated sample was much faster drying process than HAD control, SCD control, SCD cuts and $Na_2CO_3$ and SCD $Na_2CO_3$ treated sample. HAD cuts and steamed and HAD $Na_2CO_3$ treated sample took 330 min. to remove the moisture from 78 % to 5 %, whereas HAD control, SCD control, SCD cuts and $Na_2CO_3$ and SCD $Na_2CO_3$ treated sample required 360, 360, 420 and 450 min, respectively for removing the same amount of moisture.

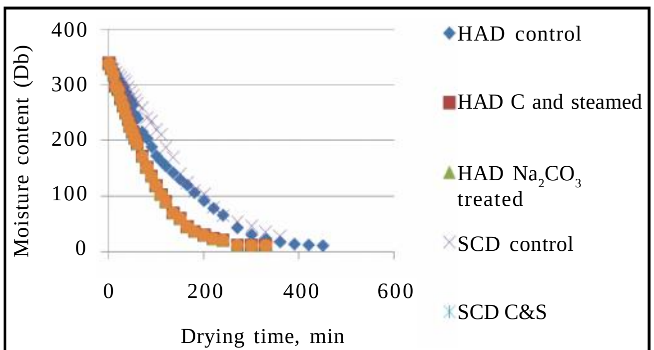


**Fig. 1 : Effect of pre-treatment on moisture content of green peas**

**Rehydration kinetics :**

*Rehydration characteristics:*

Rehydration is an important quality attribute for dried products. The rehydration characteristics indicate the physical and chemical changes during drying as influenced by processing conditions, pre-treatment, and composition of samples. The values of rehydration ratio at different rehydration temperatures was calculated. It was observed that the rehydration ratio of pre-treated samples resulted in the highest rehydration, compared to the control samples (Singh *et al*., 2006).

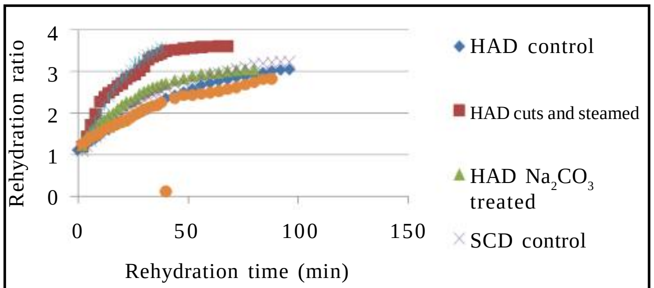


**Fig. 2 : Rehydration characteristics of green peas at 50°C**

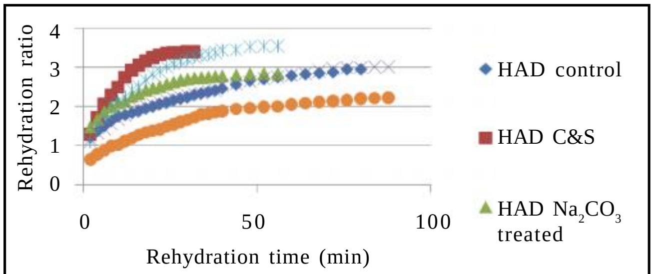


**Fig. 3 : Rehydration characteristics of green peas at 70°C**

## Effect of various drying process on the color of green peas :

The Average values of three chromatic scales (L,

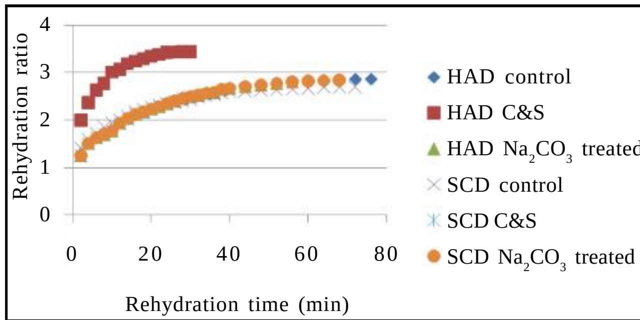


**Fig. 4 : Rehydration characteristics of green peas at 90°C**

a, b) measured on the surface of both fresh and dried green peas were as shown in Table 1, 2, 3 and 4. The negative value of b indicates the green colour. The L, a, b values of dried green peas was brighter and more greenish, respectively compared to the other sample. As we know that when the values of ΔE is closer to 1, the colour difference is very less. So from the table, we can conclude that the value of ΔE of hot dried cuts with steamed sample was closer to the colour of fresh sample compared to other dried sample.

## Effect of various drying process on the hardness of green peas :

As illustrated in Table 1 HAD cuts and steamed and SCD $Na_2CO_3$ treated sample had higher hardness values than HAD control, SCD control, SCD cuts and

**Table 1 : Measured color values for fresh and dehydrated samples**

| Drying process | Color values | | | ΔE |
|---|---|---|---|---|
| | L* | a* | b* | |
| FRESH | 49.24 | -17.593 | 31.879 | ------ |
| HAD Dried Control | 35.818 | -4.855 | 22.462 | 20.76263 |
| HAD Dried cuts and steamed | 34.592 | -6.036 | 22.785 | 20.75642 |
| HAD Dried $Na_2CO_3$ | 30.402 | -8.797 | 22.431 | 22.83647 |
| SCD Dried Control | 41.641 | -1.597 | 17.063 | 23.08962 |
| SCD Dried cuts and steamed | 46.072 | -0.437 | 24.777 | 18.83621 |
| SCD Dried $Na_2CO_3$ | 49.293 | 1.663 | 21.882 | 21.69646 |

**Table 2 : Measured color values for fresh and rehydrated samples at 50°C**

| Drying process | Color values | | | ΔE |
|---|---|---|---|---|
| | L* | a* | b* | |
| FRESH | 49.24 | -17.593 | 31.879 | ------ |
| HAD Dried Control | 45.347 | -3.811 | 24.054 | 27.99453 |
| HAD Dried cuts and steamed | 44.522 | -10.236 | 28.401 | 9.406458 |
| HAD Dried $Na_2CO_3$ | 44.231 | -9.038 | 28.248 | 10.55757 |
| SCD Dried Control | 49.73789 | -0.78956 | 23.89322 | 18.61119 |
| SCD Dried cuts and steamed | 63.071 | 0.259 | 32.959 | 22.60878 |
| SCD Dried $Na_2CO_3$ | 59.919 | 1.592 | 24.856 | 23.05272 |

**Table 3 : Measured color values for fresh and rehydrated samples at 70°C**

| Drying process | Color values | | | ΔE |
|---|---|---|---|---|
| | L* | a* | b* | |
| FRESH | 49.24 | -17.593 | 31.879 | ------ |
| HAD Dried Control | 33.604 | -6.56267 | 22.55933 | 21.28401 |
| HAD Dried cuts and steamed | 40.337 | -8.785 | 31.275 | 12.5383 |
| HAD Dried $Na_2CO_3$ | 40.011 | -11.249 | 30.105 | 11.33878 |
| SCD Dried Control | 45.66867 | -0.12367 | 21.24067 | 20.7631 |
| SCD Dried cuts and steamed | 50.077 | -4.134 | 28.352 | 13.61515 |
| SCD Dried $Na_2CO_3$ | 53.468 | 1.889 | 22.087 | 22.21053 |

**Table 4 : Measured color values for fresh and rehydrated samples at 90°C**

| Drying process | Color values | | | ΔE |
|---|---|---|---|---|
| | L* | a* | b* | |
| FRESH | 49.24 | -17.593 | 31.879 | ------ |
| HAD Dried Control | 45.095 | -3.785 | 25.625 | 15.71478 |
| HAD Dried cuts and steamed | 48.428 | -9.388 | 36.822 | 9.613252 |
| HAD Dried $Na_2CO_3$ | 45.456 | -3.604 | 30.279 | 14.57981 |
| SCD Dried Control | 50.164 | -0.904 | 26.246 | 17.63823 |
| SCD Dried cuts and steamed | 61.738 | -1.627 | 35.902 | 20.67118 |
| SCD Dried $Na_2CO_3$ | 56.92598 | -0.29391 | 28.77124 | 19.18309 |

**Table 5 : Hardness values for dried samples**

| Samples | Hardness values(g) |
|---|---|
| FRESH | 5092 |
| HAD Dried Control | 29329 |
| HAD Dried cuts and steamed | 30725 |
| HAD Dried $Na_2CO_3$ | 22850 |
| SCD Dried Control | 22902 |
| SCD Dried cuts and steamed | 24586 |
| SCD Dried $Na_2CO_3$ | 32427 |

$Na_2CO_3$ and HAD $Na_2CO_3$ treated sample.

## Conclusion :

In traditional method, drying of green peas takes more time and during the process of drying, contamination takes place on a large scale. The present work was aimed to find out the Dehydration and rehydration kinetics of green peas were studied on Hot Air Dryer (HAD) and Solar Conduction Dryer (SCD) for untreated and pre-treated samples. The two pre-treatments used were 1. Partial cuts on the surface, followed by steaming for 2 mins and 2. Blanching in 1% $Na_2CO_3$ solution for 2 mins.

Rehydration was carried out under conditions of varying temperature (50, 70 and 90 °C) and time (5 and 10 mins). Hardness, Rehydration Ratio and Colour (L*a*b* values) was measured for fresh, dried and rehydrated samples to find the optimum pre-treatment and drying method for efficient rehydration.

Studies on green pea revealed that by Partial surface cuts followed by steaming was found to be the better pre-treatment for both HAD and SCD dried peas whereas colour after rehydration was better retained in HAD dried peas. Thus, steaming as a pre-treatment gave better results as compared to blanching.

## Nomenclature :

HAD- hot air dryer

HAD C- hot air dryer – control

HAD C and S- hot air dryer cuts and steamed

HAD $Na_2CO_3$ treated- hot air dryer $Na_2CO_3$ treated sample

SCD- solar conduction dryer

SCD C- solar conduction dryer – control

SCD C and S- solar conduction dryer cuts and steamed

SCD $Na_2CO_3$ treated- solar conduction dryer $Na_2CO_3$ treated sample.

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