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Various physical dimensions of green peas (*Pisum Sativum* L.)

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Abstract
The investigation on various physical dimensions of green peas (*Pisum sativum* L) was conducted in which included two pre treatments (un-blanched and blanched). Matured fresh green peas were procured from APMC market, Navsari and deshelled manually to prepare samples. Green peas were blanched at 85 °C for 1 min and cooled in running water and removed the surface moisture. The physical dimensions of unblanched and blanched fresh green peas in terms of physical parameters such as test weight (g), size and shape, sphericity, volume (cm^3), shrinkage ratio were studied. The average test weight (1000 seed), mean length, width, thickness, arithmetic mean diameter, geometric mean diameter and sphericity of green peas were 516.2 g, 11.34 mm, 10.82 mm, 10.38 mm, 10.84 mm, 10.85 mm and 0.942, respectively. The average surface areas, volume, shrinkage ratio of green peas were 258.68 mm^2, 99.97 cm^3 and 1.0, respectively.

Keywords: Green peas, physical dimensions, shrinkage ratio

Introduction
Pea (*Pisum sativum* L.) is one of the most important and popular leguminous vegetable crops grown throughout the world and it ranks top ten among the vegetable crops and belongs to Fabaceae family. The world wide pea's production in 2017 is about 20 million tonnes. The major green peas producing countries in the world are China, India, United States, France, United Kingdom and Egypt (FAO, 2017) [6]. The area and production of green peas in India is about 5, 46,000 ha and 5.45 million tonnes, respectively (NHB, 2017) [1]. The major Pea producing states are Uttar Pradesh, Punjab, Himachal Pradesh, Odisha, Karnataka and Haryana, etc (Senapati *et al*., 2019) [14]. The post harvest Losses of green peas is about 10.3% (Nanda *et al*., 2012) [11]. The medicinal action of green peas are antioxidant and anti-inflammatory, blood sugar regulation and heart health promotion and the medicinal uses are heart disease, diabetes, stomach cancer and ulcers, etc. (Nutrition, 2015) [12]. Size and shape is an important physical attributes of green peas seed and it is used in grading, sorting and determination of seed surface area which correlate the machine design parameters for different agricultural process operations such as handling, harvesting, threshing, cleaning, conveying, sorting, drying etc. Pre-treatment i.e. blanching prevents the loss of colour by inactivating enzymes, relaxing tissue structure with better quality yields of a finished product. Green peas are blanched in hot water at 85 °C for 1 min and then immediately placed under running cold water for at least 3 min and removed the surface moisture (Doymaz and Kocayigit, 2011) [3].

Materials and Methods
Sample Preparation
Fresh green peas having initial moisture content about (77% wb) were procured from the APMC market, Navsari District, Gujarat. The peas pods were thoroughly washed to remove the dirt adhering to pods. Damaged and diseased pods were sorted out. After the sorting of pods, shelling was done manually by hands and seeds were graded according to their size. Prior to processing, green peas were manually shelled and seeds were blanched at 85°C for 1 min and cooled in running water and removed the surface moisture.

Test Weight of un-blanched and blanched green peas
Test weight (g) of 1000 seeds of both of un-blanched and blanched fresh green peas uniform size was taken with an accuracy of 0.001 g.

Length, width and thickness
The principal dimensions i.e. length (l), width (b) and thickness (t) of 100 numbers of randomly selected fresh green peas were measured by using a digital caliper with an accuracy of 0.01 mm. Size is an important physical attributes of green peas seed and it is used in grading, sorting and determination of seed surface area and to correlated volume and weight.

Shape of green peas seed
The shape of the object describes in terms of a geometrical body and was measured by combining the size measurements. The shape of green peas seed was mostly resembles near round to spherical shape by Mohsenin (1986) [9]. The arithmetic mean diameter (Da) was calculated by using the following equation

$$D_a = (l+b+t)/3 \quad \ldots\ldots\ldots\ldots (1)$$

The geometric mean dimension, D_g of the seed was calculated by using the relationship given by Mohsenin (1986) [9]

$$D_p = (lbt)^{1/3} \quad \ldots\ldots\ldots\ldots (2)$$

Where
D_p = Geometric mean dimension;
l = Length of the seed (longest intercept)
b = Width of the seed (intercept perpendicular to a)
t = Thickness of the seed (intercept perpendicular to a and b)

The longest dimension of green peas seed was taken as length while other two dimensions i.e., width and thickness were taken as perpendicular to each other and taken as average diameters.

Sphericity
Sphericity (Sp) of an object resembles a sphere. The geometric foundation of the concept of sphericity rests upon the isoperimetric property of a sphere. The sphericity was estimated by following equation given by Mohsenin (1986) [9] and it is defined as the ratio of the diameter of a sphere and the diameter of the smallest circumscribing sphere and generally, the largest diameter of the particle. This parameter shows the shape character of green pea and it is calculated following equation given by Mohsenin (1986) [9].

$$\text{Sphericity (Sp)} = \frac{(lbt)^{\frac{1}{3}}}{l} = \frac{\text{Geometric mean Dimension } (D_p)}{\text{Longest intercept (l)}} \ldots. (3)$$

Surface area (mm^2)
The surface area (Sa) was determined by analogy of a sphere in mm^2 using the following equation (Mohsenin, 1986) [9]:

$$Sa = \pi D p^2 \quad \ldots\ldots\ldots\ldots (4)$$

Where Sa =surface area, mm^2
D_p = geometric mean dimension, mm

Volume (cm^3)
Green pea seeds volume was measured by Toluene displacement method. Green peas seeds of 100 g were kept in a beaker, which was having of capacity 250 mL and was full of toluene. The submerged green peas seed displace a volume of liquid equals to the volume of green peas seed and was measured by a graduated cylinder. (Mohsenin, 1986) [9].

Shrinkage ratio
For measuring the shrinkage ratio in fresh blanched as well as during drying samples of 100 g green peas were selected. The initial apparent volumes of green peas were determined by toluene displacement method with an accuracy of 0.1 mL. The final volume was measured. Each experiment was replicated thrice. The shrinkage ratios were calculated as the ratio of volume at any moisture content level to their corresponding initial volume (Nagvanshi *et al*., 2017) [10].

$$\text{Shrinkage ratio} = \frac{\text{Final Volume}}{\text{Initial volume of sample used}} \ldots\ldots\ldots \quad (5)$$

Results and Discussion
The results of investigation on various physical dimensions of blanched as well as un-blanched fresh green peas samples such as test weight, size and shape, volume (cm^3) and sphericity, shrinkage ratio were evaluated.

Test Weight of un-blanched and blanched fresh green peas (g)
The data of average test weight of un-blanched and blanched fresh green peas are presented in Table 1.The mean test weight of un-blanched green peas was 503.85 g with a minimum weight of 495 g and maximum weight of 508 g whereas, the mean test weight of blanched green peas was 528 g with a minimum weight of 523 g and maximum weight of 535 g. It was evident from data that the mean test weights of blanched green peas were higher as compared to un-blanched green peas. Increased in test weight of blanched green peas may be attributed to fact that blanching removed entrapped gas in products. Test weight and seed weight are used as an indicator of general grain quality and is a measure of grain bulk density (Deivasigamani and Swaminathan (2018) [2]. Similar data were reported by Singh and Chandra (2014) [15] for kidney bean of two varieties like red small kidney bean and black kidney and Ganjloo *et al*. (2018) [4] for green peas.

Table 1: Test weight of unblanched as well as blanched fresh green peas

Treatment	Test Weight(1000 seed) (g)		
	Max	Min	Mean
P_1 (Un-blanched)	506	504	503.85
P_2 (Blanched)	534	508	528.50
Mean			516.17

Length (mm)
The data of length of un-blanched and blanched fresh green peas are presented in Table 2. 100 green pea seeds were selected for the determination of physical diameter (*viz*. Length). The mean length of un-blanched green peas was 11.40 mm with a minimum value of 11.10 mm and maximum value of 11.70 mm whereas the mean length of blanched green peas was 11.39 mm with a minimum value of 11.08

mm and maximum value of 11.72 mm. It was evident from data that there is no difference between the mean length of blanched green peas. Blanching has no effect on length of fresh green peas. Similar results were reported by Singh and Chandra (2014) [15] for kidney bean of two varieties like red small kidney bean and black kidney bean, Ganjloo *et al*. (2018) [4] for green peas and Sonboier *et al*. (2018) [16] for green peas (cv. Arkel) which was used to correlate the machine design parameters for different agricultural process operations such as handling, harvesting, threshing, cleaning, conveying, sorting, drying etc.

Width (mm)

Table 2 shows the data of width of un-blanched and blanched fresh green peas. 100 numbers of green pea seeds were selected for the determination of physical diameter (*viz*. width). The mean width of un-blanched green peas was found to be 10.88 mm with a minimum value of 10.59 mm and maximum value of 10.91mm whereas for blanched green peas it was 10.76 mm with a minimum value of 10.56 mm and maximum value of 10.90 mm. It was evident from data that there is no significant difference between the mean width of blanched green peas. Blanching has no effect on width of fresh green peas. Similar results on width were reported by Singh and Chandra (2014) [15] for kidney bean of two varieties like red small kidney bean and black kidney bean, Ganjloo *et al*. (2018) [4] for green peas and Sonboier *et al*. (2018) [16] for green peas (cv. Arkel).

Thickness (mm)

The data of thickness of un-blanched and blanched fresh green peas are presented in Table 2. 100 green pea seeds sample were selected for the determination of thickness. The mean thickness of un-blanched green peas was 10.40 mm with a minimum value of 10.19 mm and maximum value of 10.47 mm whereas for blanched green peas it was 10.37 mm with a minimum value of 10.18 mm and maximum value of 10.45 mm. It was evident from data that there is no difference between the mean thickness of blanched green peas. Blanching has no effect on thickness of fresh green peas. Similar results on thickness were reported by Singh and Chandra (2014) [15] for kidney bean of two varieties like red small kidney bean and black kidney bean, Ganjloo *et al*. (2018) [4] for green peas and Sonboier *et al*. (2018) [16] for green peas (cv. Arkel). Mohsenin (1986) [9] has effectively highlighted the imperativeness of the axial diameters in machine design.

Table 2: Length, width and thickness of un-blanched as well as blanched fresh Green peas

Treatment	Length (mm)			Width (mm)			Thickness (mm)		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
P1	11.70	11.10	11.40	10.91	10.59	10.88	10.47	10.19	10.40
P2	11.72	11.12	11.39	10.90	10.56	10.76	10.45	10.18	10.37
Mean		11.34				10.82			10.38

P1 (Un-blanched) and P2 (Blanched)

Shape of the seed

In identification of shape of green peas, the data of arithmetic mean diameter (D_a) as well as the geometric mean diameter (D_g) of un-blanched and blanched green peas are presented in Table 3. 100 fresh green pea seeds sample were selected for the determination of physical diameter (*viz*. arithmetic mean diameter (D_a) as well as the geometric mean diameter (D_g).The mean arithmetic mean diameter (D_a) of un-blanched green peas was 10.87 mm with a minimum value of 10.76 mm and maximum value of 11.13 mm whereas for blanched green peas, it was 10.83 mm with a minimum value of 10.51 mm and maximum value of 11.12 mm. It was evident from data that there is no difference between the mean arithmetic mean diameter (D_a) of blanched green peas and un-blanched green peas. Blanching has no effect on arithmetic mean diameter (D_a) of fresh green peas.

The mean geometric mean diameter (D_g) of un-blanched green peas was 10.86 mm with a minimum value of 10.75 mm and maximum value of 10.99 mm whereas for blanched green peas it was 10.83 mm with a minimum value of 10.50 mm and maximum value of 11.13 mm. It was evident from data that there is no significant difference between the mean geometric mean diameter (D_g) of blanched green peas and un-blanched green peas. Blanching has no effect on geometric mean diameter (D_g) of fresh green peas. Similar results on arithmetic mean diameter as well as geometric mean diameter were reported by Singh and Chandra (2014) [15] for kidney bean of two varieties like red small kidney bean and black kidney bean, Ganjloo *et al*. (2018) [4] for green peas and Sonboier *et al*. (2018) [16] for green peas (cv.Arkel).

Sphericity

The shape of the green peas was expressed by its sphericity. The data of sphericity of un-blanched and blanched fresh green peas are presented in Table 3. The mean sphericity of un-blanched green peas was 0.945 with a minimum value of 0.93 and maximum value of 0.97 whereas mean sphericity of blanched green peas was 0.935 with a minimum value of 0.92 and maximum value of 0.968. It was evident from data that there is no difference between the mean sphericity of blanched green peas and un-blanched green peas. Blanching has no effect on sphericity of fresh green peas sample. Similar results on sphericity were studied by Khanbarad *et al*. (2014) [7] for pigeon pea and Ganjloo *et al*. (2018) [4] for green peas. Sphericity value indicates that fresh green peas are closer to spherical shape.

Table 3: Arithmetic mean diameter, geometric mean diameter and sphericity of unblanched as well as blanched fresh Green peas

Treatment	Arithmetic mean diameter			Geometric mean diameter			sphericity		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
P1	11.13	10.76	10.87	10.99	10.75	10.86	0.97	0.93	0.95
P2	11.12	10.51	10.83	11.16	10.50	10.83	0.97	0.92	0.94
Mean			10.85			10.84			0.94

P1 (Un-blanched) and P2 (Blanched)

Surface area (Sa)

The data of surface area of un-blanched and blanched green peas are presented in Table 4. The mean surface area (Sa) of un-blanched green peas was 258.85 mm^2 with a minimum value of 253 mm^2 and maximum value of 265 mm^2 whereas mean surface area for blanched green peas it was 258.52 mm^2 with a minimum value of 252.98 mm^2 and maximum value of 264.88 mm^2. It was evident from data that there is no difference between the mean surface area (Sa) of blanched green peas and un-blanched green peas. Blanching has no effect on surface area of fresh green peas. The surface area is a relevant tool in determining the shape of the seed. This will actually be an indication of the way the seed will behave on oscillating surfaces during processing. Similar results on surface area were reported by Singh and Chandra (2014) [15] for kidney bean of two varieties like red small kidney bean and black kidney bean, Ganjloo *et al*. (2018) [4] for green peas and Sonboier *et al*. (2018) [16] for green peas (cv.Arkel).

Volume (cm^3)

Table 4 presents the volume data of 100 g un-blanched and blanched fresh green peas. The mean volume of un-blanched green peas was 99.97 cm^3 with a minimum value of 99.81 cm^3 and maximum value of 100.0 cm^3 whereas mean volume of blanched green peas was 99.85 cm^3 with a minimum value of 99.15 cm^3 and maximum value of 100.0 cm^3. It was evident from data that there is no difference between the volume of blanched and un-blanched green peas. Blanching has no effect on volume of fresh green peas. Volume is dependent on the three linear diameters, the change in linear diameters reflected in the change in volume too. Similar data on volume were reported by Khanbarad *et al*. (2014) [7] for pigeon pea.

Table 4: Surface area, volume and shrinkage ratio of unblanched as well as blanched fresh Green peas

Treatment	Surface area (mm^2)			Volume(cm^3)/ 100 g			Shrinkage ratio		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
P1	265.11	253.05	258.85	100	99.81	99.97	1.0	1.0	1.0
P2	264.88	252.98	258.52	100	99.15	99.85	1.0	0.992	1.0
Mean			258.68			99.97			1.001

P1 (Un-blanched) and P2 (Blanched)

Shrinkage ratio

Table 4 presents the shrinkage ratio (100g of sample) of un-blanched and blanched fresh green peas. The mean shrinkage ratio of un-blanched green peas was 1.0 with a minimum value of 1.0 and maximum value of 1.0 whereas shrinkage ratio of blanched green peas was 1.0 with a minimum value of 0.99 and maximum value of 1.0. It was evident from data that there is no difference between the shrinkage ratio of blanched and un-blanched green peas. Blanching has no effect on shrinkage ratio of fresh green peas. Similar results reported by Senadeera *et al.* (1999) [13] for green peas; Honarvar *et al.* (2011) [5] for green peas and Liu *et al.* (2012) [8] for carrot slices.

Conclusions

Size and shape is an important physical attributes of green peas seed and it is used in grading, sorting and determination of seed surface area which correlate the machine design parameters for different agricultural process operations such as handling, harvesting, threshing, cleaning, conveying, sorting, drying etc. From above study it could be concluded that the average test weight (1000 seed), mean length, width, thickness, arithmetic mean diameter (Da) geometric mean diameter (Dg) and sphericity of green peas were is 516.2 g, 11.34 mm, 10.82 mm, 10.38 mm, 10.84 mm, 10.85 mm, 0.942, respectively. The average surface areas, volume, shrinkage ratio of green peas were 258.68 mm^2, 99.97 cm^3 and 1.0, respectively.

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