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Study of Physical Properties of Custard Apple and Utilization of Pulp and Waste Material

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A B S T R A C T

The study was carried out in the Department of Agricultural Process Engineering, College of Agricultural Engineering & Technology, VNMKV, Parbhani (Maharashtra), India during the year of 2017-18.It was carried out for study of physical properties of Custard Apple, utilization of pulp &utilization of waste material. The physical properties of custard apple fruits (*Annona squamosa* L.*)* obtained from the farmer's field were determined. This property included fresh fruit weight, size, arithmetic mean diameter, sphericity, surface area, true density, seeded pulp content, deseeded pulp content, peel content, number of seeds per fruit and volume of custard apple fruit varied in the ranged of 138 to 244 gm, 63.85 to 77.66 mm, 59.28 to 70.755 mm, 0.92 to 1.00, 109.02 to 172.66 cm², 0.74 to 1.7 g/cc, 88 to 120 gm, 72 to 112 gm, 32.89 to 62.94%, 26 to 48 and 110 to 200 cm³, respectively. This study showed considerable variation in some physical properties of custard apple fruit. These properties can be useful for the design of process equipment for custard apple consumed by human beings. Powder form of waste material from custard apple can be used as an "adsorbent" for cleaning the industrial water which contains the higher amount of dangerous chemicals in it."Leather" which is made-up from the pulp of custard apple can be used for giving the flavor to any product which is consumed by human beings.

Introduction

Custard apple, also known as Seetaphal in India, is a subtropical fruit belonging to the Annonacea family. The botanical name of custard apple is *Annona squamosa* Lin. The fruit grows on a small deciduous tree and is known by different names worldwide. The fruit is around 8 centimeters in diameter and has a sweet and delicious taste. The shape of the fruit may be lopsided, irregular, spherical, heart-shaped, or round. It has a creamy and granular textured flesh, surrounded by seeds. The skin of the fruit is thin and tough, mostly black and green in colour. The fruit is native to West Indies, Central America, Peru and Mexico. In dryland areas, custard apple (*Annona squamosa* L.) has occupied a unique place due to hardy nature for biotic and abiotic stresses, which belongs to the family Annonaceae, and have a native of tropical America. The black seeds are surrounded by white, creamy pulp which is very

sweet and pleasantly flavored. The custard apple is mostly used as a dessert fruit for its delicious taste and nutritive values.

The pulp is used in the preparation of ice-cream and beverages. Custard apple fruit is an excellent source of carbohydrates, minerals, and protein. It is also a good source of vitamin A and C. Generally, the fruit is grown on hills and barren land and farmers used to collect the fruit from these plants and sell them in the market. The demand for custard apple started growing in last few years and some dishes like *'Sitaphalrabdi'* and *'sitaphal* ice-cream' gained tremendous popularity. Therefore, the demand for the fruit has been increased and many farmers decided to cultivate the fruit. The production of custard apple in India for the year 2012-13 was 1,35,640 MT from an area of 19,550 ha. (Anonymous, 2012). As the main season of harvesting the fruits is very short (October to November), there is usually glut leading to wastage and distress sale. Storage of the fresh fruits has limitations, since it is perishable, and cold storage is not promising because of the development of unattractive brown colour on the skin which decreases the market value. The custard apple pulp can be stored up to 3 months. The good quality graded fruits are sold at higher prices in the market as compared to the relatively small size fruits, though small size fruits yield a good quality of pulp.

Physical specification of agricultural products constitutes the most important parameters needed in the design of grading, transfer, processing, and packaging systems. Physical specification of agricultural products mass, volume and center of gravity are of high importance in sizing system. Parameters measurable through sizing system are dimensions (length, width, height), surface area and weight. However, information on above aspect of custard apple is scantly, therefore, present experiment was undertaken to study the physical properties of custard apple fruit.

Fruit has gained considerable importance because of its sweet pulp being medicinally valuable and it is good source of carbohydrates (23.5 %), minerals (0.9 %) and proteins (1.6 %). Processed products of custard apple such as jam, jelly, crush etc. has more demand in the market if they have flakes along with the pulp. Custard apple pulp has also great demand in ice-cream industry. Custard Apple has its delightful taste, flavor, moderate price in markets and a high nutritional status. Due to its climacteric nature, it ripens fast and spoiled easily. Like many other tropical fruits, the mature custard apple fruit gets a chilling injury if stored below 15°C, for six weeks. Out of the ripening temperature of 15, 20 and 25°C, 20°C gave the most acceptable fruit for fresh consumption. The addition or removal of ethylene had no effect on the ripening of custard apple.

The chemical preservatives are used to prevent the food spoilage due to microbial attack. The antioxidants can be used to control enzymatic browning. Ascorbic acid is probably the most widely used anti-browning agent. Potassium metabisulphite (KMS) are also used as preservatives for long-term storage of fruit pulp because of their better antimicrobial activity.

Materials and Methods

Custard apple fruits (*Annona squamosa L.)* were procured from the farmer's field. Randomly selected 18 fruits were taken as study sample. Chemical Solution : Potassium Metabisulphite ($K_2S_2O_5$).

Method for preparation of Powder from Waste Material of Custard Apple: Take a whole custard apple sample, clean it, cut it & remove seeded pulp from fruit coat, take fruit coat (waste material), weight it and place it in the dryer and mark an observatory sample & weight it, adjust the temperature of the dryer to 60°C, taking the weight of observatory sample at the interval of 30 minutes for determination of moisture content, after total moisture content gets removed i.e. sample is completely dried, take out all waste material from the dryer, cool it at room temperature, crush it by using a mixer, here, the required powder is formed. Method for preparation of Leather from Pulp of Custard Apple :Take a whole custard apple, clean it, cut it & remove seeded pulp from the coat, take

seeded pulp in 500 ppm KMS (Potassium Metabisulphite) solution for 5 minutes (Solution is prepared by dissolving 1 gm of KMS into 1 litre of clean water), take out the seeded pulp from solution, remove pulp from seed (i.e. free from all waste material) by rubbing the seeded pulp on wire mesh sieve, taking clean pulp and grind it by using a mixer, clean pulp is then put on the rectangularly shaped plastic paper boat and make a thin film of pulp on it, put this boat in water-bath for 02:30 hours, where the temperature of the water should not exceed than 75°C, remove a boat from water-bath & cool it at room temperature, remove leather (pulp film) from the plastic boat, here, the required transparent leather film is formed.

Physical Properties

Weight

Weight (g) of custard apple fruit was measured using an electronic balance with an accuracy of 0.01g.Axial Dimensions: Three principal axes (length, breadth and thickness) of the fruit were measured with the help of Vernier calliper having a least count of 0.02 mm. Size: The size of fruit was calculated by using following formula. Size (Dg)=$(LXBXT)^{1/3}$,Where, L=Major axial dimension, mm, B=Intermediate axial dimension, mm, T=Minor axial dimension, mm. Arithmetic Mean Diameter: Arithmetic mean diameter (Da) for each custard apple fruit was calculated using following equation,

$$\text{Da} = \frac{(LXBXT)}{3}$$

Sphericity

The sphericity (Φ) of fruits was calculated using following formula,

$$\Phi = \frac{(L\ X\ B\ X\ T)^{1/3}}{L}$$

Surface Area

The surface area of custard apple fruit was calculated by using following formula, S = π x Dg², Where, S=Surface area, mm², Dg=Geometric mean diameter mm. Volume of Fruit: Fruit volumes were measured by water displacement method.

Fruits were weighed in air and allowed to float in water. Fruits were lowered with a needle into a graduated beaker containing water and mass of water displaced by the individual fruit was recorded.

$$\text{Volume}(\text{cm}^3) = \frac{Weight\ of\ displaced\ water\ (g)}{Weight\ density\ of\ water\ (\frac{g}{cm^3})}$$

True Density of Fruits

True density of fruit was calculated using following equation,

$$\text{True density}\ (\text{g/cm}^3) = \frac{Fruit\ Mass\ (g)}{Fruit\ Volume\ (cm^3)}$$

Seeded Pulp Content

Custard apple pulp scooped manually and weight of seeded pulp recorded. Seeded pulp content of custard apple was calculated by using following formula,

$$\text{Seeded pulp content}\ \% = \frac{W_{SP}}{W_F} \text{X}100$$

Where, W_{SP} =Weight of seeded pulp, g, W_F =Weight of fruit, g.

Peel Content

Peel content of custard apple was calculated by using following formula,

$$\text{Peel content}\ \% = \frac{W_P}{W_F} \text{X}100$$

Where, W_P =Weight of peel, g, W_F =Weight of fruit, g.

De-Seeded Pulp Content

De-seeded pulp content of custard apple was calculated by using following formula,

$$\text{De-seeded pulp content } \% = \frac{W_{DP}}{W_F} X100$$

Where, W_{DP}=Weight of de-seeded pulp, g, W_F=Weight of fruit, g.

Seed Content

Seeds from the custard apple pulp were separated manually and weight of seed per fruit was recorded. Seed content of custard apple was calculated by using following formula,

$$\text{Seed content } \% = \frac{W_S}{W_F} X100$$

Where, W_S=Weight of seed, g, W_F=Weight of fruit, g.

Number of Seeds

Seeds of custard apple were separated from each fruit and counted manually.

Roundness

It is the major of sharpness of the corners of a solid. Roundness of custard apple fruits was calculated by using following formula,

$$\text{Roundness} = \frac{A_P}{A_C}$$

Where, A_p=Largest projected area of object in natural rest position, A_C=Area of smallest circumscribed circle.

Results and Discussion

This study showed considerable variation in some physical properties of custard apple fruit. These properties can be useful for the design of process equipment for custard apple. More studies of physical and chemical properties in the relation among different cultivars need to be undertaken. Powder form of waste material from custard apple can be used as an "adsorbent" for cleaning the industrial water which contains the higher amount of dangerous chemicals in it.

"Leather" which is made-up from the pulp of custard apple can be used for giving the flavor to any product which is consumed by human beings. For faster separation of pulp, the machine can be recommended. Separated pulp could be stored at -20°C with 0.1% potassium metabisulphite (KMS) as anti-browning agent for 180 days.

Table.1 The 100 gram of custard apple is having nutrition in following forms

Principle	Nutrient Value
Calories	80-101 Kcal
Protein	6.8 g
Fat	0.5 g
Carbohydrate	20 g
Fiber	0.9 g
Calcium	17.6 mg
Phosphorous	14.7 mg
Iron	0.42 mg
Carotene	0.007 mg
Thiamine	0.075 mg
Riboflavin	0.086 mg
Niacin	0.528 mg
Ascorbic acid	15 mg
Nicotinic acid	0.5 mg

Volume, Density & Specific Gravity

Sample	Weight of sample (gm)	Volume of displaced water (ml)	Density
1	174	150	1.16
2	138	120	1.15
3	166	140	1.18
4	166	135	1.22
5	210	195	1.07
6	190	160	1.18

Weight of Sample, Seed, Waste & Pulp

Sample	A	B	C	Sphericity	Surface Area, mm²
1	73.66	61.87	72.76	0.939	444630.57
2	61.52	55.08	61.25	0.966	325858.32
3	75.41	54.31	68.37	0.867	414032.02
4	66.28	60.57	69.85	0.987	377818.95
5	79.10	63.55	77.17	0.922	490945.95
6	71.52	59.47	67.98	0.924	411412.13

Table.2 First Trial of Observations

Sphericity & Surface Area

Sample	Total sample wt. (gm)	Weight of seed (gm)	Weight of waste (gm)	Weight of Pulp (gm)
1	174	13	68	93
2	138	16	50	72
3	166	8	86	72
4	166	18	66	82
5	210	8	90	112
6	190	14	64	112

Roundness

Sample	A_P (cm²)	A_C (cm²)	Roundness
1	36	28.27	1.27
2	36	36.31	0.99
3	36	28.27	1.27
4	36	32.16	1.11
5	53	47.78	1.10
6	41.5	38.48	1.07

Table.3 Second Trial of Observations

Volume, Density & Specific Gravity

Sample	Weight of sample (gm)	Volume of displaced water (ml)	Density
1	156	125	1.248
2	160	120	1.333
3	186	135	1.377
4	244	200	1.22
5	176	125	1.408
6	152	110	1.381

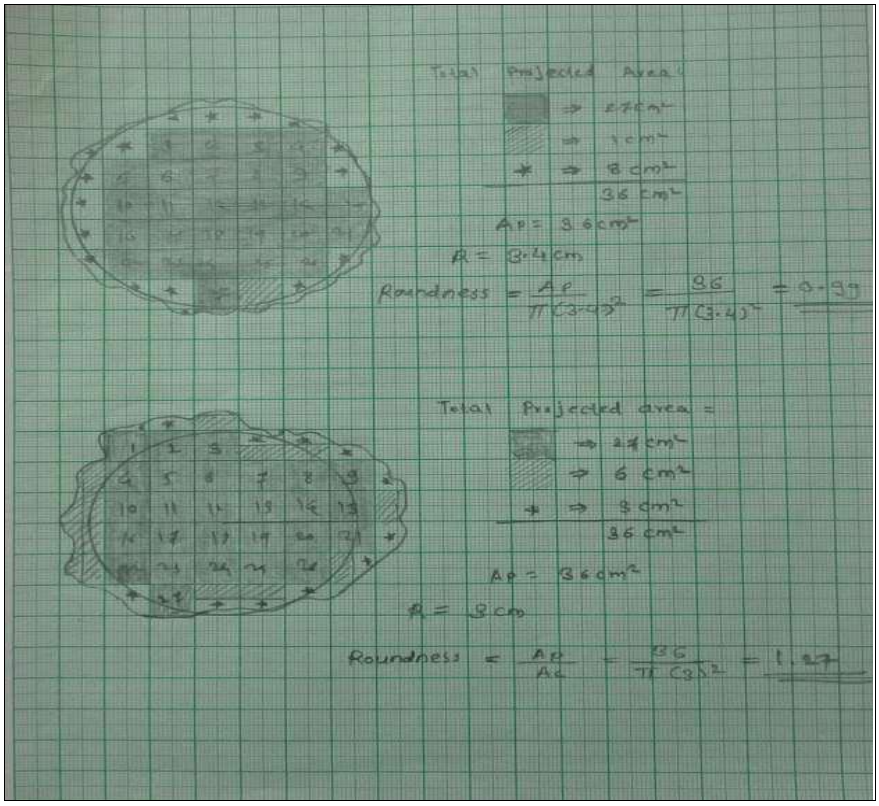
Sphericity & Surface Area

Sample	A	B	C	Sphericity	Surface Area, mm^2
1	71.20	50.83	69.53	0.886	364887.71
2	67.35	64.70	68.18	0.990	403097.38
3	72.13	65.56	72.45	0.970	445760.36
4	83.65	64.20	85.15	0.921	531124.81
5	72.12	68.12	72.02	0.980	457802.20
6	68.02	61.10	67.64	0.963	393133.26

Roundness

Sample	A_P (cm^2)	A_C (cm^2)	Roundness
1	43	38.48	1.11
2	38	32.16	1.18
3	43	34.21	1.25
4	58.5	50.26	1.16
5	41	38.48	1.06
6	38	34.21	1.11

Graph.1 Graph Diagrams for Calculating Roundness of Custard Apple Fruits



Graph.2 Graphs of Moisture Content Vs Time for Pulp of Custard

Fig.1 Pulp without KMS solution

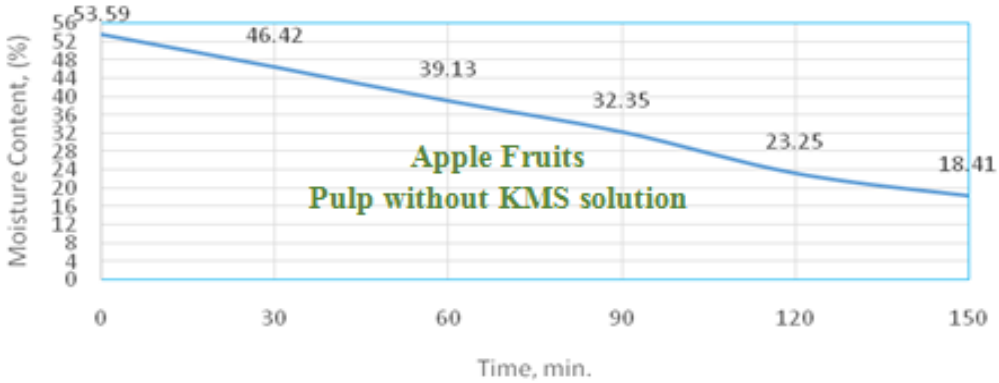
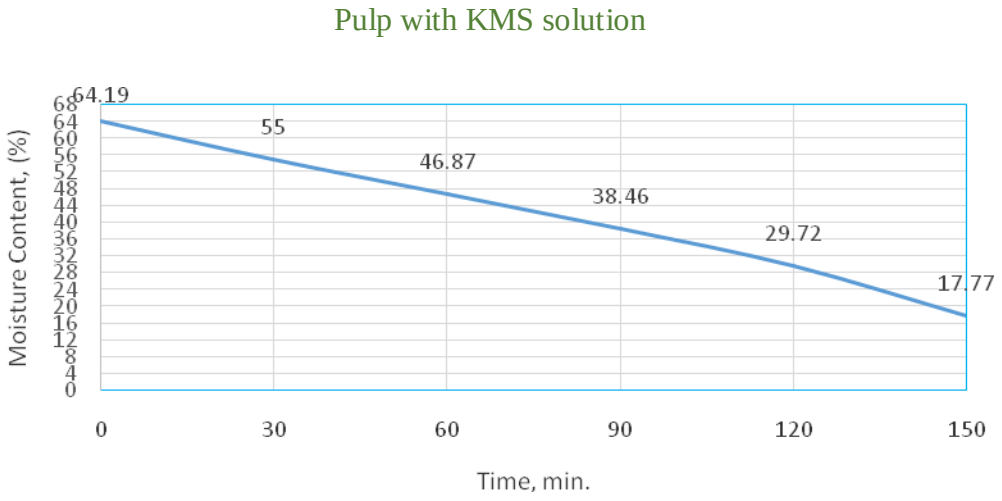


Fig.2 Pulp with KMS solution



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