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Rheological Properties of Custard Apple Pulp-Flakes

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ABSTRACT

The studies on rheological properties of custard apple pulp-flakes is important for determining the different processing conditions and unit operations related to extraction of pulp-flakes. Separation of flakes of custard apple from seeds need to study the force required for the separation. In the present study, the rheological properties such as stickiness, cohesiveness, viscosity were determined along with the shear force required to separate the pulp-flakes from seeds. The maximum shear force required to separate seeds from flakes was found to be 2.53 N. The minimum, maximum and average measured values of stickiness of custard apple pulp were 22.80 g, 414.05 g and 184.40 g, respectively. The measured values of viscosity and torque were 50.9 cP and 33.07 Nm, respectively.

Key Words: Custard apple, Pulp-flakes, Shear force, Stickiness, Viscosity.

INTRODUCTION

The custard apple (*Annonasquamosa* L.) is one of the tropical fruits. It is usually eaten as a dessert fruit and finds immense applications in the preparations of beverages and ice creams (Kad *et al*, 2016). The fruit has gained considerable importance because of its sweet pulp being medicinally valuable. The fruit is good source of carbohydrates (23.5 %), minerals (0.9 %) and proteins (1.6 %) (Gopalan *et al*, 1991). The pulp is also used in different processed products such as jam, jelly, *rabadi*, shake. However retention of flakes is of more important during pulp extraction to have good organoleptic properties of processed products (Kad *et al* ,2015). The studies on rheological properties of custard apple pulp-flakes is important for determining the different processing conditions and unit operations related to pulp-flakes extraction. Separation of flakes of custard apple from seeds need to study the force required for the separation. In the present study, the rheological properties such as stickiness, cohesiveness, viscosity were demined along with the shear force required to separate the pulp-flakes from seeds.

MATERIALS AND METHODS

Procurement of raw material

Uniform size and healthy fruits of custard apple Cv. Local were procured from All India Co-ordinated Research Project on Arid Zone Fruits (Fig and Custard Apple), Jadhavwadi, Tahasil-Purandhar, District- Pune and from the orchards of progressive farmers for the experiments.

Rheological properties custard apple pulp-flakes

Rheological properties *viz*., shear force, viscosity, torque, hardness, cohesiveness and stickiness of fifteen custard apple pulp-flakes samples were recorded.

Force required to separate the seeds from flakes

It is the force required to produce a major break/ rupture in a sample to separate the seeds from the flakes was measured with the help of texture

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analyzer (M/s. Brookfield Engineering Labs, Inc., USA). Texture analyzer was equipped with a 50 N load cell and TA3/100 probe operated at a test of 1 mm/s transversally.

Pulp stickiness

Stickiness/adhesiveness is the work/force necessary to overcome the attractive forces between the surface of the product and the surface of the probe with which the product comes in contact. It was commonly the textural property measured by texture analyzer and is hardness *cohesiveness (which is Area 2/Area1) (Peleg, 1996 and Breene, 2007). Hardness is the force required to compress a substance between the molar teeth or between tongue and plate to a given deformation or penetration and designated as soft, firm or hard.

Viscosity of pulp

The viscosity of custard apple pulp is a measure of its resistance to gradual deformation by shear stress or tensile stress. The viscosity of fresh custard apple pulp samples is measured with the help of Brookfield Viscometer DV-II+Pro. The spindle (probe) no. 64 was used for measurement of viscosity at 200 rpm with constant sample temperature 23.4^{0}C.

RESULTS AND DISCUSSION

Shear force required to separate the seeds from flakes

The maximum shear force required to separate seeds from flakes was 2.53 N (Table 1). The thickness of wire as determined by considering shearing force of single carpel and total number of carpel along the length of cylinder was 0.40 mm in diameter.

The similar results were reported by Kad *et al* (2016) for custard apple, Soliva *et al* (2002) for fresh cut pears, Costell *et al* (1995) for sweet orange and Kokini and Carrilo (1989) for tomato paste.

Hardness and Cohesiveness

Hardness and cohesiveness of custard apple pulp were recorded in the range of 120 to 1470 g and 0.09 to 0.61, respectively. The results are in agreement with the values reported by Kad *et al* (2016) for custard apple.

Table 1. Measurement of shear force requiredto separate the seeds from flakes

Sr. No.	Replication	Shear force (N)
1	R1	2.25
2	R2	1.35
3	R3	1.65
4	R4	1.53
5	R5	2.53
6	R6	1.46
7	R7	2.16
8	R8	1.38
9	R9	2.26
10	R10	1.86
Average		1.84

Pulp stickiness

The value of stickiness is required for the adjustment of angle of casing and discharge of pulp – flakes outlet, so that pulp discharges smoothly and easily. The data on pulp stickiness of fifteen custard apple pulp samples was calculated and an average value is shown in Table 2. The minimum, maximum and average measured values of stickiness of custard apple pulp were 22.80 g, 414.05 g and 184.40 g, respectively. The results were in agreement with the values reported by Kad *et al* (2016) for custard apple.

Viscosity of pulp

The average value of ten samples for viscosity and torque of custard apple pulp is given in Table 3. The measured values of viscosity and torque were 50.9 cP and 33.07 Nm, respectively. The results were in agreement with the values reported by Sigita *et al* (2013) for apple pulp and Shahnawaz and Shiekh (2011) for jamun fruit juice, squash and jam.

Table 2. Measurement of pulp stickiness of custard apple pulp.

Sr. No.	Replication	Hardness (g)	Cohesiveness	Stickiness (g)
1	R1	120	0.19	22.80
2	R2	285	0.20	57.00
3	R3	170	0.29	49.30
4	R4	565	0.39	220.35
5	R5	760	0.39	296.40
6	R6	665	0.31	206.15
7	R7	1470	0.23	338.10
8	R8	500	0.24	120.00
9	R9	735	0.09	66.15
10	R10	540	0.30	162.00
11	R11	340	0.61	207.40
12	R12	845	0.49	414.05
13	R13	225	0.26	58.50
14	R14	500	0.33	165.00
15	R15	1235	0.31	382.85
			Average	184.40

Table 3. Measurement of viscosity of custard apple pulp.

Sr. No.	Replication	Viscosity (cP)	Torque Nm
1	R1	50.7	32.4
2	R2	50.8	32.6
3	R3	51.9	34.6
4	R4	52.3	34.9
5	R5	49.8	32.0
6	R6	49.3	31.8
7	R7	50.0	32.1
8	R8	50.4	32.2
9	R9	51.8	33.5
10	R10	52.0	34.6

CONCLUSION

The maximum shear force required to separate seeds from flakes was 2.53 N. The minimum, maximum and average measured values of stickiness of custard apple pulp were 22.80 g, 414.05 g and 184.40 g, respectively. The measured values of viscosity and torque were 50.9 cP and 33.07 Nm, respectively.

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