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Effect of power operated and hand pricking method on TSS of aonla candy

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Abstract
The present study was carried out to study effect of different pricking method on TSS of whole pricked aonla candy. The TSS indicates the total soluble solids in aonla fruit contributing the main factor in the chemical quality of aonla fruit, it was found to be increasing with the passage of days of syruping for preparation of aonla candy. The pricking of aonla is one of the important unit operation leading to improved TSS. The various processed products such as murabba, preserves etc. needs to increase the sugar uptake and water loss by means of osmosis. Pricking causes sugar to penetrate deep into aonla and the moisture to seep out on account of osmosis. The power operated aonla pricking machine was developed as an alternative to traditional tedious time consuming process of pricking. For single pass, the values of TSS for the treatment S_1A_1 combination of power operated pricking machine as 70.00 °B were found to be more than the values of TSS for the treatment H_1P_1 i.e. hand pricking machine as 59.10 °B up to nine days syruping. For double pass the values of TSS for the treatment S_1A_1 was more than remaining four treatment combination of power operated pricking machine as 70.00 °B were found to be more than the values of TSS for the treatment H_1P_1 i.e. hand pricking machine as 66.90 per cent up to nine days syruping. The values of TSS were found to be higher at higher RPM and lower angle of inclination for double pass compared to single pass. The TSS values were observed to be higher i.e. 70°B at 80 RPM and 6° angle of inclination as compared to all other treatment combinations.

Keywords: TSS – Total Soluble Solid, °B- Degree brix, H_1P_1 - hand pricking method, S_1 – Speed at 80 RPM, A_1-Angle of inclination at 6° and RPM-Rate per minute

Introduction
Aonla is considered as "Wonder fruit for health**"** because of its unique qualities**.** It is one of the minor fruit crops of commercial significance. It has acquired wide popularity all over the world due to its medicinal properties. It is one of the three constituents of the famous ayurvedic preparation, triphala, which is prescribed in many digestive disorders (Chopra *et al.*, 1958; Parmar and Kaushal, 1982) [11]. Also aonla has been an important ingredient for Chavanprash and Ayurvedic health tonic. It has played an important therapeutic role from time immemorial and is frequently recommended for its synergistic effects in both the Ayurvedic and Unani systems of medicine (Jain *et al.*, 1983) [5]. Aonla is a very rich source of vitamin 'C' and other nutrients like polyphenols, pectin, iron calcium and phosphorus, the fruit is a potent antioxidant, hypolipidemic, antibacterial, antiviral and antiacidic. It is a rich source of vitamin C and its content of ascorbic acid is next to only that of Barbados cherry (*Malpighia glabra* L.). It contains 600- 1000mg/100 g vitamin C.

Pricked aonla is immersed in sugar solution for making preserves, murabba or candies. Pricking causes sugar to penetrate deep into Aonla and the moisture to seep out on account of osmosis. Osmotic dehydration is a process of partial removal of water by soaking foods, mostly fruits and vegetables, in hypertonic solutions. The driving force for the diffusion of water from the plant tissue into the solution is difference between osmotic pressures of hypertonic solution and plant tissue. The diffusion of water is accompanied by simultaneous counter diffusion of solutes from the solution into the tissue (Lazarides *et al.*, 1995) [9]. Leakage of the natural solutes from the plant tissue occurs because the cell membranes of plant tissue responsible for osmotic transport, is not perfectly selective but this flow is negligible, although it may be important for the organoleptic and nutritional properties of the product (Heng *et al.*, 1990) [4]. Osmotic dehydration, which is effective even at ambient temperature and saves the colour, flavour and texture of food from heat, is used as a pretreatment to improve the nutritional, sensorial and functional properties of food.

In food industries, pricking is done with the help of an ordinary fork having four spikes. The hand pricking method used in India were obsolete and inefficient (Kakde and Awate, 2012) [8], hence a power operated aonla pricking machine was introduced in preserve making industries to speed up the operation. Thus there is vital need to develop power operated aonla pricking machine for maximum pricking of aonla

Material and Methods

Pricking of aonla fruits for candy making

Aonla Cv.NA-7 was used as the pricking material. Two different speed and two angle of power operated aonla pricking machine were considered for machine pricking *viz*., 60 RPM and 80 RPM and angle 6^0 and 10^0. Freshly harvested aonla fruits (var.NA-7) were brought from the Department of Horticulture, MPKV Rahuri. Aonla was pricked by using single and double pass through the power operated aonla pricking machine (Φ = 3 mm, each). Hand pricking machine having 18 needles (Φ = 3 mm, each) with two dies was also used for pricking.

Preparation of Aonla Candy

Treatment details

Part A - For Single Pass

Table 1: Treatment details of aonla candy by single pass

1.	Speed:	i) S_1 = 80 RPM ii) S_2 = 60 RPM
2.	Angle:	i) A_1 = 6°
		ii) A_2 = 10°
3.	Controlled:	H_1P_1 = Hand pricking
4.	Treatment combination:	2 x 2 x1 = 4
5.	Design:	Factorial Completely Randomized Design
6.	Number of replication:	3
7.	Sample size:	1 kg of aonla fruits for syruping
8.	Method of Syruping:	Cold syruping method (Standard)
		50°B sugar syrup (24 h)
		60°B Sugar syrup (24 h)
		70 °B Sugar syrup (adjusted every day upto 7 days)

Table 2: Treatment combination for making aonla candy by single pass

Single pass		
Treatment combination	**Speed (RPM)**	**Angle (°)**
S_1A_1	80	6
S_1A_2	80	10
S_2A_1	60	6
S_2A_2	60	10
H_1P_1 (Controlled)	Hand Pricking	

Part B - For Double Pass

Table 3: Treatment details of aonla candy by double pass

:1.	Speed	: i) S_1 = 80 RPM ii) S_2 = 60 RPM
2.	Angle	: i) A_1 = 6°
		ii) A_2 = 10°
3.	Controlled	: HP = Hand pricking
4.	Treatment combination	: 2 x 2 x1 = 4
5.	Design	: Factorial Completely Randomized Design
6.	Number of replication	: 3
7.	Sample size	: 1 kg of aonla fruits for syruping
8.	Method of Syruping	: Cold syruping method (Standard)
		50°B sugar syrup (24 h)
		60°B Sugar syrup (24 h)
		70 °B Sugar syrup adjusted every day upto 7 days))

Table 4: Treatment combination for making aonla candy by double pass

Double pass		
Treatment combination	**Speed (RPM)**	**Angle (°)**
S_1A_1	80	6
S_1A_2	80	10
S_2A_1	60	6
S_2A_2	60	10
H_1P_1 (Controlled)	Hand Pricking	

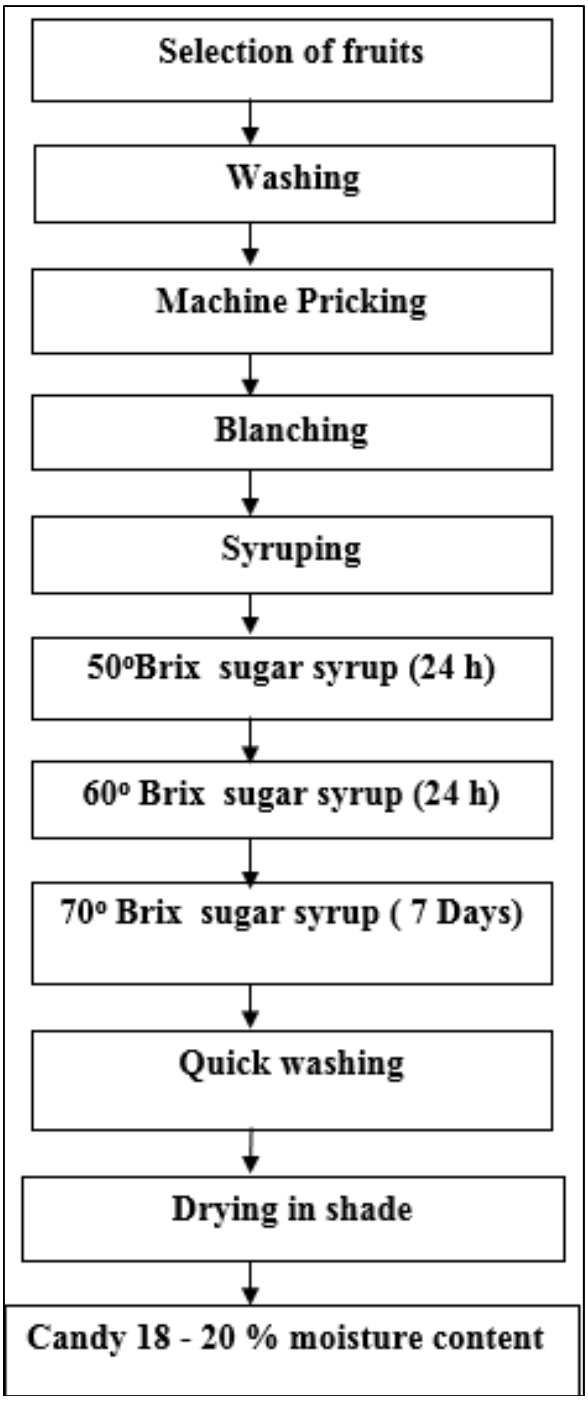

Fig 1: Flow chart of Candy making process (Cold Syruping)

Candy making process (Cold syruping)

Aonla candy was made from the pricked fruits. The sample size taken was 1 kg for each treatment with three replication. The aonla candy was prepared by using cold syruping method shown in Fig. 3.20, standardized earlier (Kadam *et al.,* 1991) [7].

Selection of fruits

The cleaned, healthy and matured aonla fruits were selected for the preparation of aonla candy.

Washing

Aonla fruits can be washed with fresh water for removing the dust particles and then wiped with a muslin cloth.

Machine pricking

The cleaned and selected fruits were pricked with the help of power operated aonla pricking machine.

Blanching

The pricked fruits were blanched by holding in a loosely tied piece of muslin cloth and dipping in the boiling water for 5 minutes. After blanching the fruits were immediately held in running tap water to prevent further cooking (Gupta *et al.,* 1981) [3].

Syruping

Sugar, the osmotic agent, was purchased from local market. The osmotic solutions of different concentrations (50°B, 60°B and 70°B) were prepared by dissolving required amounts of sugar in distilled water using magnetic stirrer. Concentrations were checked by hand refractometer. For each treatment, One kg weight of aonla fruit were put in the glass containers having calculated volume of osmotic solutions of different concentrations at the room temperature. Fruit to sugar solution ratio was taken as 1: 1

A syrup containing 50 per cent sugar was prepared and blanched fruits were dipped in this syrup for 24 h. Subsequently, the sugar content of syrup was raised by 10 °B each day upto 70 °B and treated fruits allowed to soak in 70 °B syrup for 7-8 days. During experimentation, it was assumed that the amount of solid leaching out of aonla fruit during osmosis was negligible (Lazarides *et al.* 1995) [9]. At the specified times the aonla fruit were removed from the osmotic solutions and rinsed with water to remove surplus solvent adhering to the surfaces. These osmotically dehydrated aonla fruit were then spread on the absorbent paper to remove the free water present on the surface. A proportion of the pretreated aonla fruit were used for determination of dry matter by oven method (AOAC 1990) [1]. The remaining part of each sample was dried to final moisture content of 10 % (wet basis) using a hot air drier preset at 60 °C air temperature. The dried samples were cooled in a desiccators containing silica gel for half an hour, and measuring the weight of sample.

Washing

The fruits were removed from sugar syrup quickly rinsed with lean tap water and to remove the free water present on the surface.

Drying

The sample was dried in shade on stainless steel trays till the moisture content was reduced to about 20 per cent (Patil, 2001) [12].

Result and discussion

Single pass

Effect of speed and angle on TSS for single pass pricking

The TSS indicates the total soluble solids in aonla fruit contributing the main factor in the chemical quality of aonla fruit, it was found to be increasing with the passage of days of syruping for preparation of candy. The data on changes in TSS during syruping of pricked aonla fruits by power operated and hand operated aonla pricking machine showed in Table 5 and 6.The percentage solid gain during syruping was observed to be increasing from day 1 to day 9 in all the treatment combinations of speed of operation and angle of inclination and method of pricking.

Table 5: Effect of angle and speed of aonla pricking machine on TSS for single pass

Sr. no	Syruping days	80 RPM		60 RPM	
		6 °	10 °	6 °	10 °
1	Day 1	29.50	22.67	22.67	18.50
2	Day 2	38.33	33.73	36.00	26.80
3	Day 3	46.80	43.50	42.50	37.40
4	Day 4	54.33	49.33	51.67	45.80
5	Day 5	60.23	55.33	53.17	52.67
6	Day 6	63.80	58.50	59.00	55.53
7	Day 7	67.47	62.17	62.17	57.33
8	Day 8	69.37	64.33	64.17	58.47
9	Day 9	70.00	66.13	65.17	59.57

ANOVA					
	DF	SS	MSS	F	CD @ 5%
Speed (S)	1	630.267	630.267	2076.535	S
Angle (A)	1	653.671	653.671	2153.645	S
Days (D)	8	20663.890	2582.986	8510.144	S
A X D	8	31.533	3.942	12.986	S
SXD	8	17.467	2.183	7.194	S
SXA	1	0.008	0.008	0.025	S
AXSXD	8	43.980	5.498	18.113	NS
Error	72	21.853	0.304		
Total	107	22062.669			

	S. E.	CD @ 5%
Factor A	0.319	0.905
Factor B	0.075	0.213
Interaction	0.318	0.902

Comparison of power operated and hand operated aonla pricking machine on TSS for single pass

The data on effect of different pricking methods on TSS are shown in Table 6 and Fig.2. The maximum TSS was observed in power operated pricking machine as compared to hand pricking machine in single pass. The values of TSS for the treatment S_1A_1 combination of power operated pricking machine as 70.00 °B were found to be more than the values of TSS for the treatment H_1P_1 i.e. hand pricking machine as 59.10 °B up to nine days syruping.

Table 6: Effect of pricking method on TSS during syruping for single pass

Number of days	Single pass TSS				
	S_1A_1	S_1A_2	S_2A_1	S_2A_2	H_1P_1
1	29.50	22.67	22.67	18.50	18.40
2	38.33	33.73	36.00	26.80	26.60
3	46.80	43.50	42.50	37.40	37.20
4	54.33	49.33	51.67	45.80	45.40
5	60.23	55.33	53.17	52.67	52.60
6	63.80	58.50	59.00	55.53	55.40
7	67.47	62.17	62.17	57.33	57.23
8	69.37	64.33	64.17	58.47	58.20
9	70.00	66.13	65.17	59.57	59.10

* Each value is the average of three replication

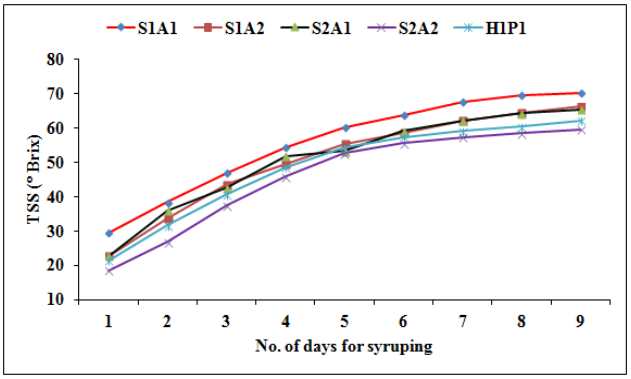

Fig 2: Effect of different pricking methods on TSS (°B) during syruping for single pass

Double pass

The similar trend was observed for double pass treatments, with considerable higher values of TSS compared to single pass due to increased pricked area in double pass. The data on changes in TSS during syruping of pricked aonla fruits by power operated and hand operated aonla pricking machine showed in Table 6 and 8. The TSS during syruping was observed to be increasing from day 1 to day 9 in all the treatment combinations of speed of operation and angle of inclination and method of pricking.

Effect of speed and angle on TSS for double pass pricking

The TSS observed to be increasing from day 1 to day 9 in all the treatment combinations. The TSS was considerably greater for double pass. This is because of increase pricked area by double pass treatment. The effect of angle of inclination of plate and speed of operation of aonla pricking

machine on TSS was found to be statistically significant. The TSS was observed to be more at 80 RPM compared to 60 RPM at both 6° and 10° angle of inclination. This might be because of more per cent of pricked area and more TSS leading to loss of water due to osmotic pressure. The maximum TSS was found in 80 RPM and 6° (S_1A_1) followed by 80 RPM and 10° (S_1A_2) and minimum in 60 RPM and 10° (S_2A_2).

Table 7: Effect of angle and speed of aonla pricking machine on TSS for double pass

Sr. no.	Syruping days	80 RPM		60 RPM	
		6 °	10 °	6 °	10 °
1	Day 1	32.67	24.50	25.33	23.47
2	Day 2	42.50	36.33	42.00	36.67
3	Day 3	51.17	45.67	47.73	42.83
4	Day 4	57.33	53.33	51.33	52.17
5	Day 5	63.57	57.47	56.67	56.67
6	Day 6	67.77	62.40	66.17	60.17
7	Day 7	70.00	65.33	65.00	62.83
8	Day 8	70.00	67.50	65.00	65.27
9	Day 9	70.00	69.77	65.00	67.00

ANOVA					
	DF	SS	MSS	F	CD @ 5%
Speed (S)	1	261.271	261.271	117.683	S
Angle (A)	1	298.602	298.602	134.497	S
Days (D)	8	19739.441	2467.430	1111.388	S
A X D	8	130.607	16.326	7.354	S
SXD	8	41.311	5.164	2.326	S
SXA	1	54.301	54.301	24.458	S
AXSXD	8	36.107	4.513	2.033	NS
Error	72	159.850	2.220		
Total	107	20721.489			

	S. E.	CD @ 5%
Factor A	0.289	0.820
Factor B	0.203	0.575
Interaction	0.860	NS

Comparison of TSS by power operated and hand operated pricking machine for double pass

The data on effect of different pricking methods on TSS are shown in Table 8 and Fig.3. The maximum TSS was observed in power operated pricking machine as compared to hand pricking machine in double pass. The values of TSS for the treatment S_1A_1 was more than remaining four treatment combination of power operated pricking machine as 70.00 °B were found to be more than the values of TSS for the treatment H_1P_1 i.e. hand pricking machine as 66.90 per cent up to nine days syruping.

Table 8: Effect of pricking method on TSS during syruping for double pass

Number of days	Double pass TSS				
	S_1A_1	S_1A_2	S_2A_1	S_2A_2	H_1P_1
1	32.67	24.50	25.33	23.47	23.43
2	42.50	36.33	42.00	36.67	36.00
3	51.17	45.67	47.73	42.83	42.53
4	57.33	53.33	51.33	52.17	51.50
5	63.57	57.47	56.67	56.67	56.33
6	67.77	62.40	66.17	60.17	59.20
7	70.00	65.33	65.00	62.83	62.07
8	70.00	67.50	65.00	65.27	65.10
9	70.00	69.77	65.00	67.00	66.90

* Each value is the average of three replication

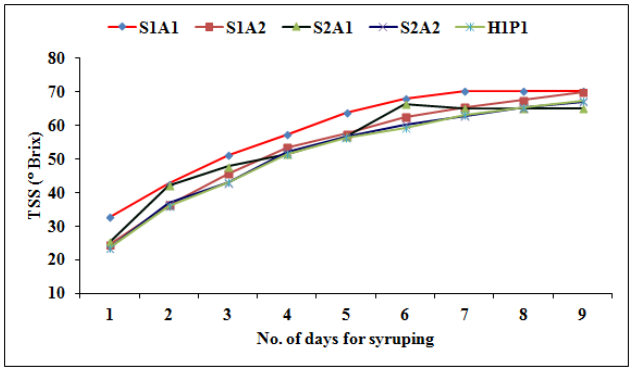

Fig 3: Effect of different pricking methods on TSS (°B) during syruping in double pass

Conclusion

The maximum TSS was observed in power operated aonla pricking machine as compared to hand pricking machine in single pass as well as double pass. The values of TSS for the treatment S_1A_1 combination of power operated pricking machine as 70.00 °B were found to be more than the values of TSS for the treatment H_1P_1 i.e. hand pricking machine as 59.10 °B up to nine days syruping. The values of TSS for the treatment S_1A_1 was more than remaining four treatment combination of power operated pricking machine as 70.00 °B were found to be more than the values of TSS for the treatment H_1P_1 i.e. hand pricking machine as 66.90 per cent up to nine days syruping. The values of TSS were found to be higher at higher RPM and lower angle of inclination for double pass compared to single pass. The TSS values were observed to be higher i.e. 70°B at 80 RPM and 6^0 angle of inclination as compared to all other treatment combinations.

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