# Influence of Various Treatments on Textural Profile Analysis of Indian Gooseberry (*Emblica officinalis*) Candy during Storage

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**A B S T R A C T**

The present investigation was carried out during 2015-16, in the Department of Horticulture, V.N.M.K.V. Parbhani, Maharashtra. Aonla (*Emblica officinalis*) also known as Indian gooseberry is one of the oldest Indian fruits and considered as "Wonder fruit for health". The aonla candy was made up by using different treatments i.e. sugar syrup solutions, dipping time and drying methods. There are two levels of sugar syrup concentrations i.e. 60% and 70%, three dipping times i.e.36 hrs, 42 hrs and 48 hrs and three drying methods i.e. sun drying, solar drying and cabinet drying. Candy was prepared by combining these treatments. Eighteen treatment combinations were taken in factorial combined randomized design with three replications. The treatment $S_1T_2M_2$ showed the highest values for hardness (43.278 kg). The hardness was found to be less in treatment $S_2T_2M_3$ (20.720 kg.). The treatment $S_2T_2M_1$ showed lowest value of cohesiveness (0.140) and treatment $S_1T_1M_3$ showed the highest value (1.384). The highest springiness value (1.172) was found in $S_1T_3M_2$ and treatment $S_2T_2M_1$ showed lowest value i.e. 0.996. Moreover, adhesiveness was found to be highest in treatment $S_2T_2M_1$ i.e. 0.297 and least in treatment $S_1T_1M_3$ i.e. 0.037. Use of Cabinet dryer during candy preparation showed more overall acceptability than sun and solar dryer. High sugar concentration imparted good colour, appearance and texture to aonla candy sensory basis.

## Introduction

Aonla (*Emblica officinalis*) is one of the unique fruit which has got great importance because of its high antioxidant and medicinal properties. Aonla (*Emblica officinalis*) or Indian gooseberry belongs to family Euphorbiaceae and is indigenous to tropical South East Asia, particularly in Central and Southern India (Parmar and Kaushal, 1982) from where it spread to Sri Lanka, Malaysia and China (Bose *et al.,* 2002). India ranks first in the world with respect to area and production of cultivated aonla (Priya and Khatkar, 2013). The estimated production of aonla in the country during the year 2014-15 was 1319 thousand tonnes from an area of 107 thousand whereas, in HP its production has

been estimated as 2390 MT from an area of 2158 ha (Anonymous, 2015). It is widely distributed in Uttar Pradesh, Maharashtra, Gujarat, Rajasthan, Andhra Pradesh, Karnataka, Tamil Nadu, Haryana and Himachal Pradesh. Although the wild aonla is widely distributed in the forests of HP up to an elevation of 1450 m above mean sea level (Parmar and Kaushal, 1982), but there are no records of its area and production. Aonla fruit is a rich source of ascorbic acid, phenols, sugars, pectin, starch and mineral like iron, calcium, phosphorous and magnesium (Nath *et al.,* 1992). Being rich source of ascorbic acid, it contains about 20 times more vitamin C than the citrus fruits (Parmar and Kaushal, 1982). Its fruits are astringent, carminative, digestive, stomachic, diuretic and antipyretic and also useful in curing many diseases like diabetes, cough, asthma, bronchitis, headache, ophthalmic disorders, dyspepsia, colic, flatulence, skin diseases, leprosy, jaundice, scurvy, diarrhoea and greyness of hair (Ganachari *et al.,* 2010). It also contains leucoanthocyanins along with polyphenols which maintain the stability of ascorbic acid as well as astringency of the fruit (Radha and Mathew, 2007). Tannins (gallic acid and elagic acid) and glucose render its value as antiscorbutic in fresh as well as dried conditions (Pareek and Kaushik, 2012). Due to its high astringency and perishable nature after harvest aonla fruits are not popular as table fruit (Kumar and Nath, 1993). Being highly perishable nature of cultivated aonla, it has limited period of availability under north Indian conditions (Bhattacherjee *et al.,* 2012). But scattered information is available in the literature with respect to the development of value added products from wild aonla. So, in view of its availability in abundance and various health benefits there is need to make use of this wild fruit for the development of various value added products. Keeping in view the availability of this fruit in the forests of HP and importance with respect to its quality characteristics, the present studies were carried out with the following objectives to develop preserve from wild aonla fruits and its quality evaluation during storage. According to FSSAI, 2006 preserve means the product prepared from sound, whole, cut or grated fruits, rhizomes or vegetables, singly or in combination, by impregnating it with sweeteners to an adequate concentration to preserve it. According to FSSAI, 2006 preserve contains at least 55 per cent fruit part and 68 $^{\circ}$B TSS.

## Materials and Methods

The aonla candy was made up by using different treatments i.e. sugar syrup solutions, dipping time and drying methods. There are two levels of sugar syrup concentrations and three dipping times and 3 drying methods i.e. sun drying, solar drying and cabinet drying. The details of materials used and methods adopted for the conduct of experiment are presented in this chapter under appropriate headings.

## Procurement of aonla fruits

The fully mature aonla fruits were procured from the local market of Parbhani district of Maharashtra. The fruits were graded and washed thoroughly with continuous stream of water to remove adherent dirt particles and other foreign materials. Good quality crystal sugar and alum were purchased from local market and used for the preparation of aonla candy.

## Equipment's and Instruments

Different equipment required for the preparation of aonla candy and for various physico-chemical characterization such as solar dryer, cabinet dryer, hand refractometer, texture analyzer etc. were made available from the Department of Utilization of animal

energy, Department of Horticulture and College of Food Technology, VNMKV, Parbhani.

## Packaging materials

The suitable packaging materials such as poly-ethylene bags (LDPE) of 200 guage and standing pouch (composite layers of Polyamide and Nylon) of 250 guage were obtained from local market of Parbhani.

## Materials and Methods

### Processing of aonla

### Washing

Aonla fruits were washed thoroughly with clean running water to remove dirt or other foreign materials.

### Blanching

Aonla fruits were tied loosely in a muslin cloth bag and dipped in boiling water for 5 to 7 minutes to soften the fruits for easy separation of segments. Then seeds were removed and segments were separated as suggested by Kumar *et al.,* (2001). The blanched segments were steeped in 2% Alum solution for 12 hrs. After steeping in alum solution the segment was washed to remove the traces of alum. The product was prepared by dipping the segments in successive increasing concentrations of sugar syrup at room temperature till equilibrium at $70^0$brix was reached as per the method described by Tondon *et al.,* (2006). Firstly $50^0$brix sugar syrup was prepared to which pre-treated segments were transferred. After soaking for 24 hours, the segments were taken out and shifted to $60^0$brix for further 24 hours. On the next day, the same syrup was boiled to the concentration $70^0$brix, which was cooled and transferred to the fruit segments which were

kept for next 3 days. On the fourth day, the osmosed segments were separated out from syrup and dipped in water for 30 sec. thoroughly to remove surface syrup to avoid stickiness. Drying was carried out by various types of dryers viz. Sun drying, solar drying, cabinet drying. When the sufficiently dry and leathery texture was achieved, product was removed from dryer and immediately packed in polyethylene bags, sealed and stored for further studies.

## Textural profile analysis

Stable Micro System *TAXT2 plus Texture* Analyzer was used for texture profile analysis (TPA) of aonla Candy. TPA is "two-bite" test, which includes the first and second compression cycles. The first and second compression cycles indicate the force vs. time data during the first and second compression of the product by the instrument probe. Representative graphs of texture analysis are obtained. The parameters recorded were hardness, fracturability, springiness, cohesiveness and gumminess. The test is configured so that the TPA parameters, hardness, fracturability, springiness, cohesiveness and gumminess were calculated at the time of the test by determining the load and displacement at predetermined points on the TPA curve Hardness (F1) was the maximum load, expressed in kg, applied to the samples during the first compression. Fracturability point occurs where the plot has its first significant peak (where the force falls off) during the probe's first compression of the product. Compressiveness (A2/A1) was the ratio of the area under the curve for the second compression (A2) to that under the first compression (A1). Adhesiveness (A3) was the area under negative peak and expressed as kg/second. Gumminess (F1xA2/A1) was the product of hardness and cohesiveness. It was expressed as kg. There were three replications of the instrumental

analysis conducted on three separate days. Instrumental TPA test was carried out by a compression test that generates plot of force (N) versus time(S) using a textural analyzer equipped with a 5-kg load cell. The analyzer was linked to a computer that recorded data via a software programme. A 75-mm diameter cylindrical plate was used to measure textural properties. The samples (0.5x0.5x0.5 cm) were taken and compressed up to 75% of their original height at a speed of 0.5mm/s with a pre-test and post-test speed of 1mm/s and 5mm/s, respectively. The data obtained from the TPA curve were used for the calculation of textural parameters (hardness, fracturability, cohesiveness, springiness and chewiness).

## Statistical analysis

All processing equipment's and analysis of samples were run in triplicate. Analysis of variance was calculated using standard ANOVA procedure. The data obtained for various treatments was recorded and statistically analyzed by Factorial complete randomized design (FCRD) to find out the level of significance as per the method proposed by Panse and Sukhatme (1967).

## Results and Discussion

### Effect of drying methods on quality of aonla candy

The results relating to the dehydration of aonla candy with respect to sugar syrup concentration, dipping time and drying methods are presented below.

### Drying Kinetics

Typical drying curves of aonla candy under convective air drying conditions at $60^{o}$C temperatures are shown in Fig.7-12. The moisture content versus time curves for drying at $60^{o}$C of aonla candy are shown in Fig.1-6.

A general trend observed was that with increase in drying time there was a gradual decrease in moisture content. The initial moisture content of aonla candy was 70%. It nearly took 4 hours to achieve 50 % moisture level at $60^{o}$C temperature in cabinet dryer. The subsequent drying pattern being slow, additional 3 hrs at $60^{o}$C temperatures was required for the samples to reach the EMC. The total time required to dry aonla candy from an initial moisture content of 70 % to EMC at $60^{o}$C in sun drying, solar drying and cabinet drying was 19 hrs, 12 hrs and 7 hrs respectively.

### Effect of different treatments on Texture Profile of aonla candy

The texture of any product plays a very important role in determining the acceptability. Texture Profile Analysis (TPA) of aonla candy was assessed using a texture analyser. The values are summarized in table 1 showed instrumental texture profiles of aonla candy of different sugar solution concentration, dipping time and different methods of drying. Their graphs are depicted in the figures 13-31.

The highest values of hardness (43.278 kg) were recorded in treatment $S_1T_2M_2$ followed by in treatment $S_1T_1M_2$ (39.166 kg). The hardness of aonla candy treated with 60% sugar syrup concentration was found harder than aonla candy treated with 70% sugar syrup concentration. The lowest value of hardness of aonla candy was found in treatment $S_2T_2M_3$ (20.720 kg). The mean value of hardness of aonla candy was 30.507.

Hardness values of samples with less sugar syrup concentration were found to be more than higher sugar syrup concentration. The work on firmness has been carried out by Phisut *et al.,* (2013) during investigation of cantaloupes.

**Fig.1** Effect of different treatment ($S_1T_1 M_1$) on per cent moisture content of aonla candy
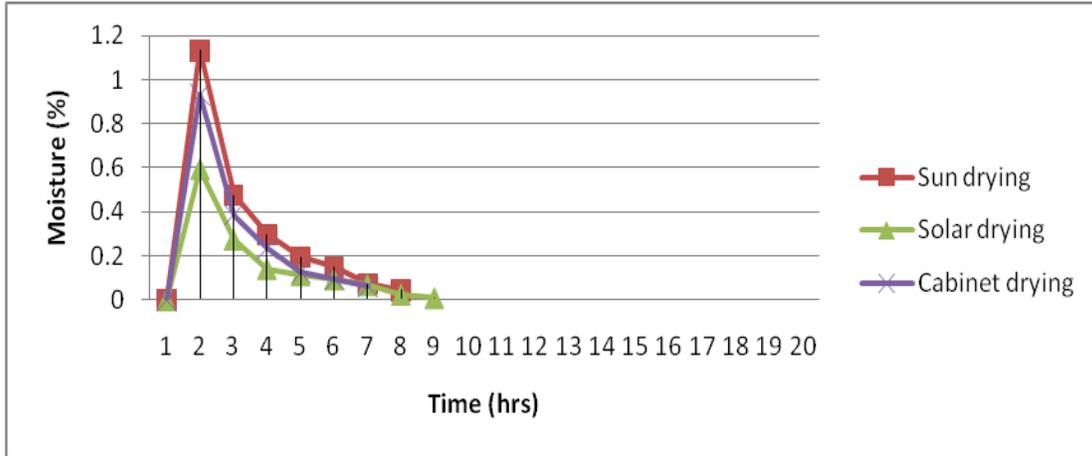


**Fig.2** Effect of different treatment ($S_1T_1 M_2$) on per cent moisture content of aonla candy
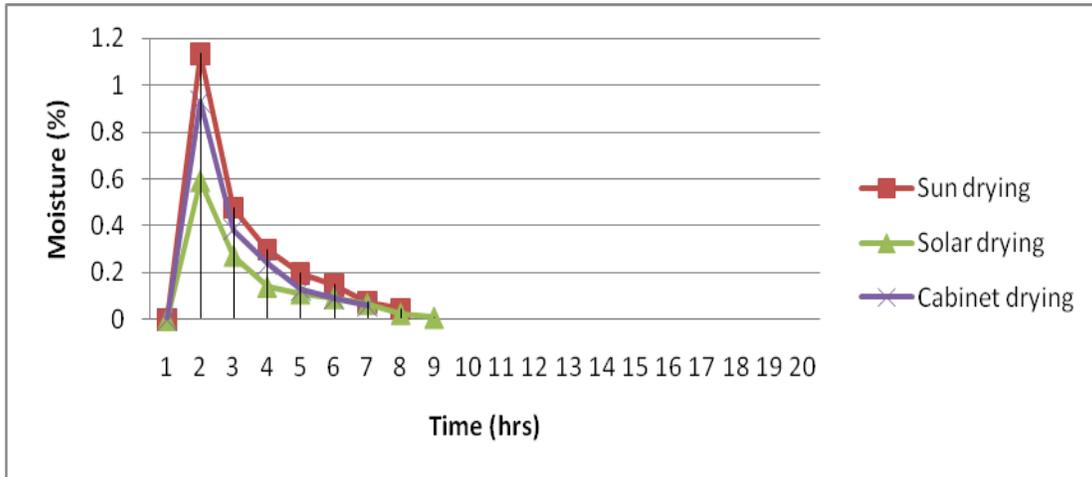


**Fig.3** Effect of different treatment $S_1T_1 M_3$) on per cent moisture content of aonla candy
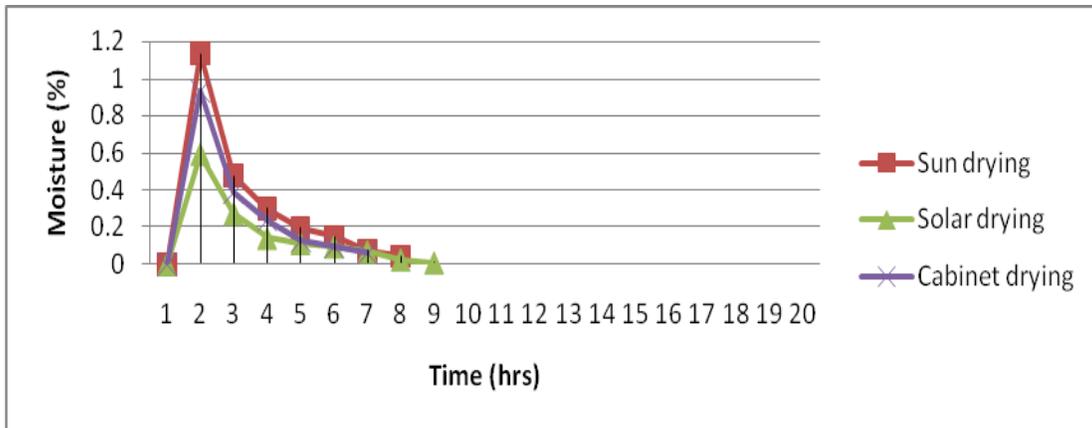
**Fig.4** Effect of different treatment ($S_2T_2 M_1$) on per cent moisture content of aonla candy
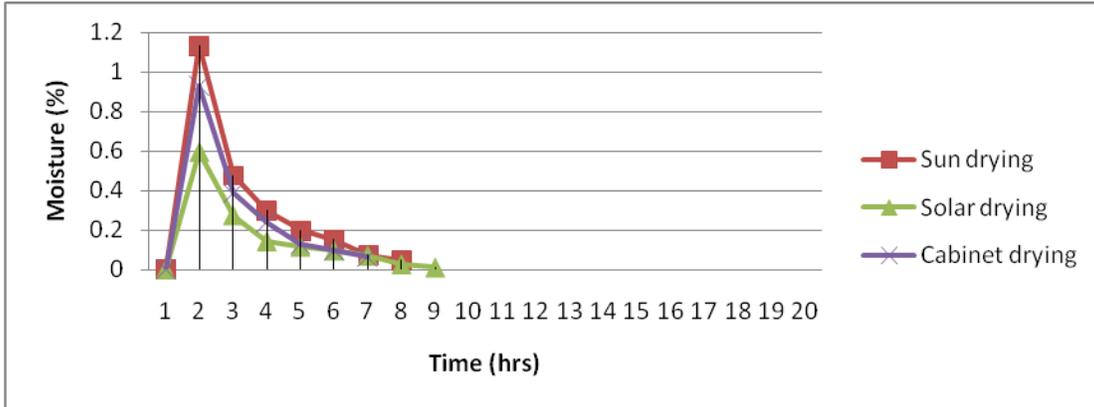


**Fig.5** Effect of different treatment ($S_2T_2M_2$) on per cent moisture content of aonla candy
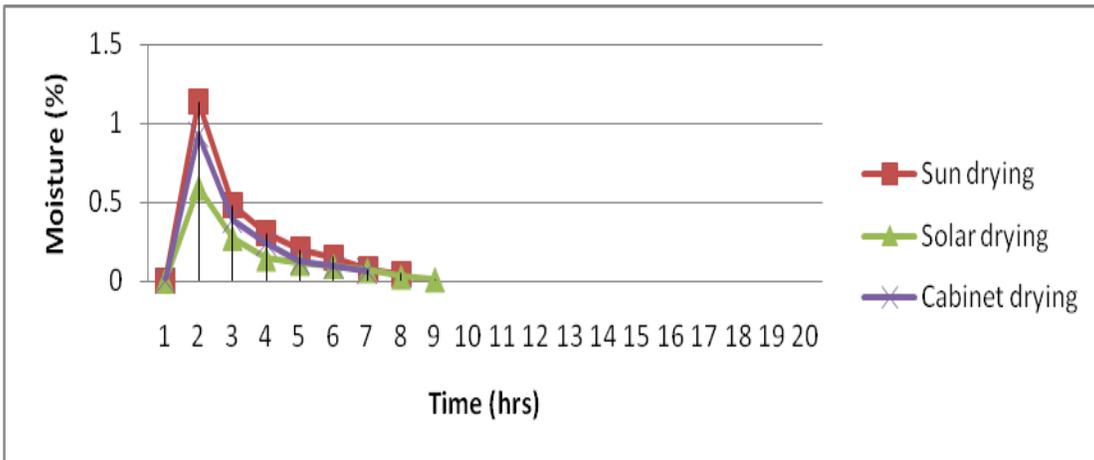


**Fig.6** Effect of different treatment ($S_2T_2 M_3$) on per cent moisture content of aonla candy
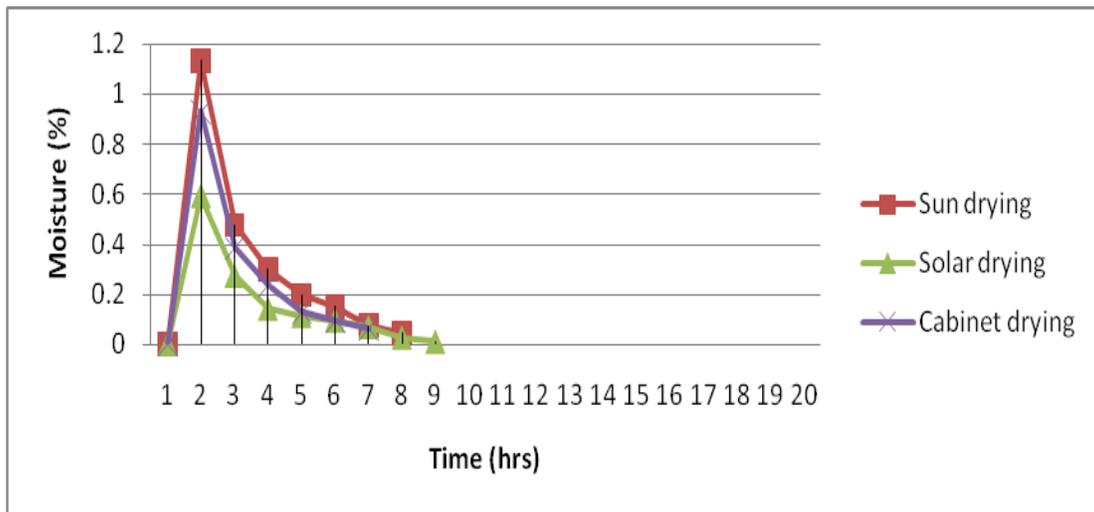
**Fig.7** Effect of different treatment ($S_1T_1 M_1$) on drying rate of aonla candy
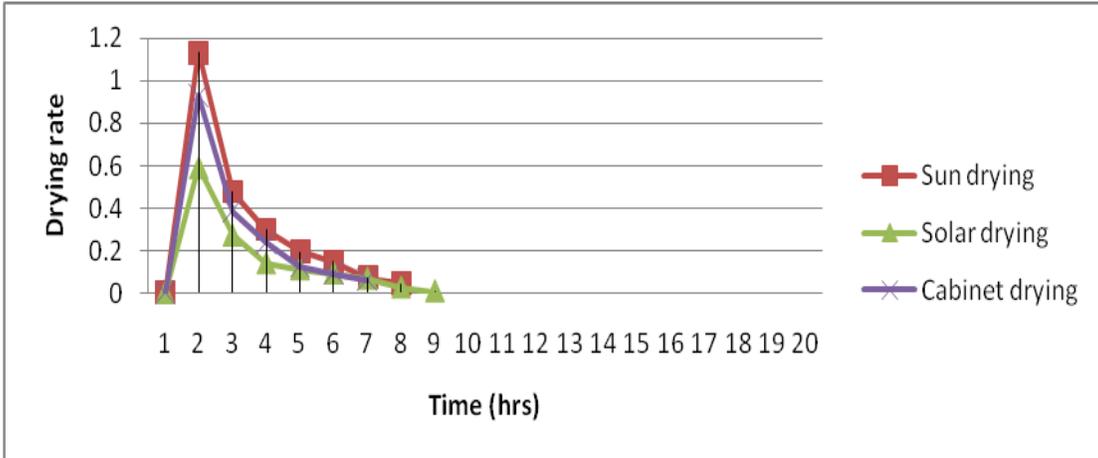


**Fig.8** Effect of different treatment ($S_1T_1 M_2$) on drying rate of aonla candy
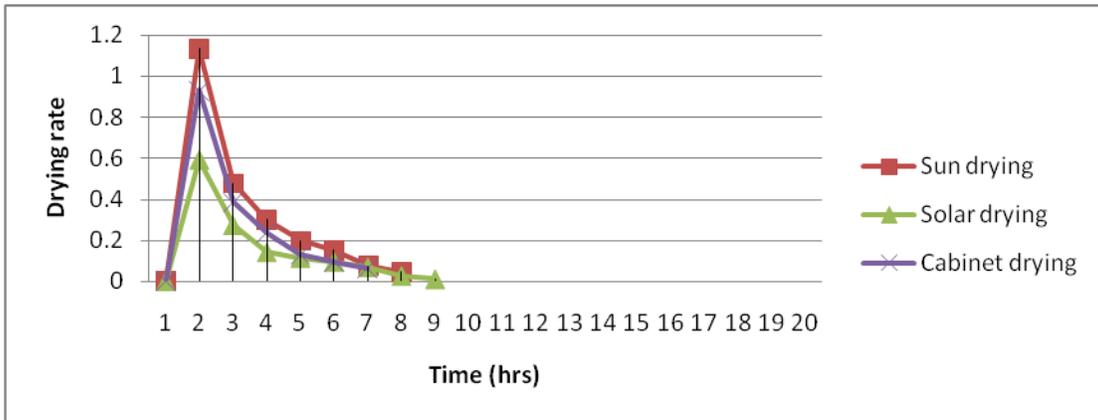


**Fig.9** Effect of different treatment ($S_1T_1 M_3$) on drying rate of aonla candy
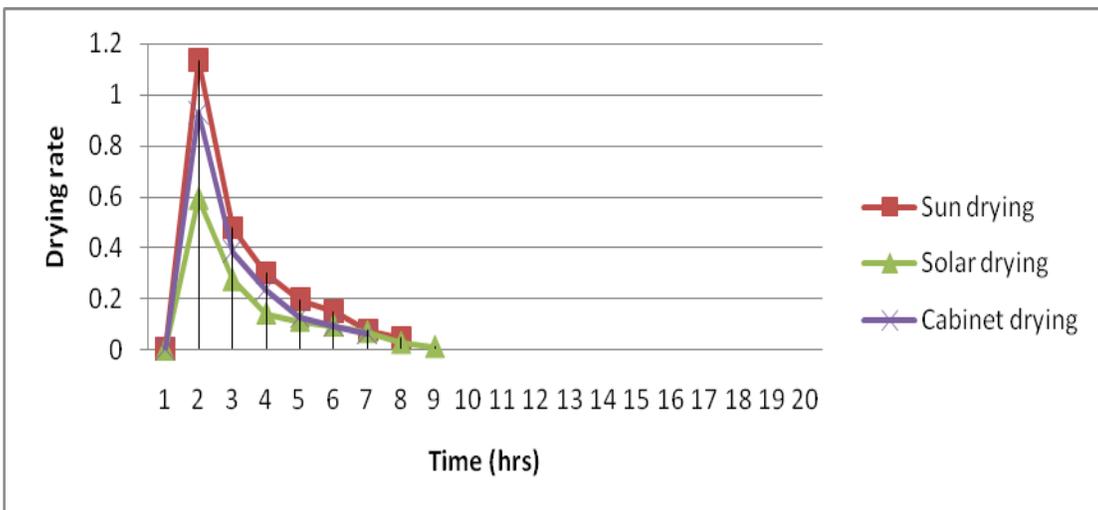
**Fig.10** Effect of different treatment ($S_2 T_1 M_1$) on drying rate of aonla candy
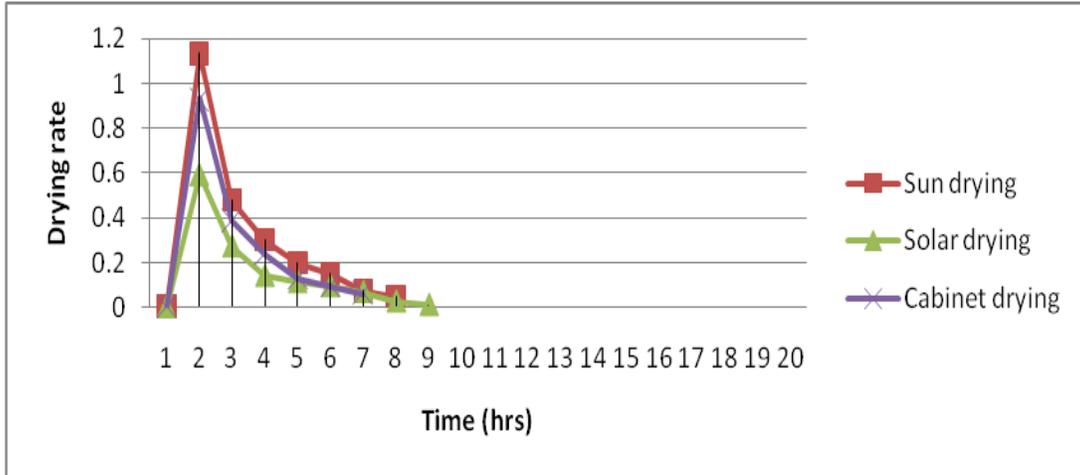


**Fig.11** Effect of different treatment ($S_2 T_2 M_2$) on drying rate of aonla candy
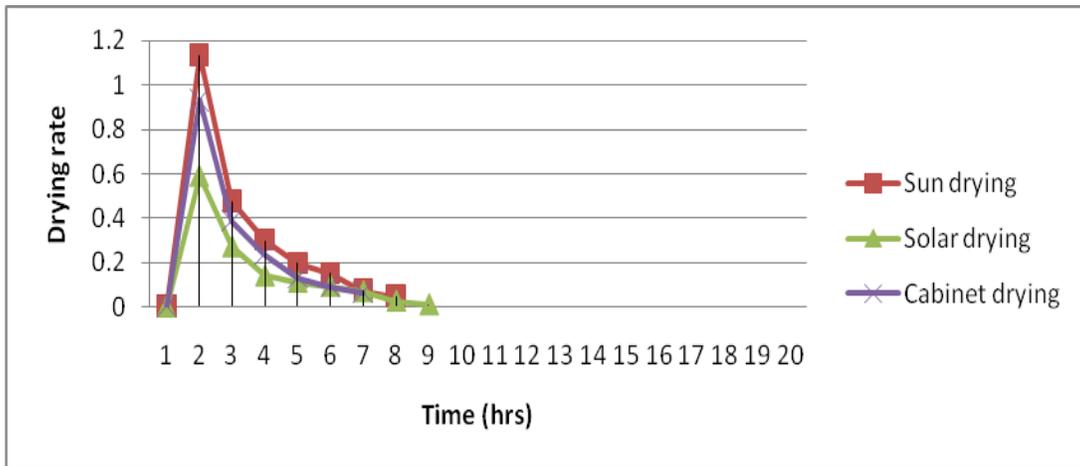


**Fig.12** Effect of different treatment ($S_2 T_2 M_3$) on drying rate of aonla candy
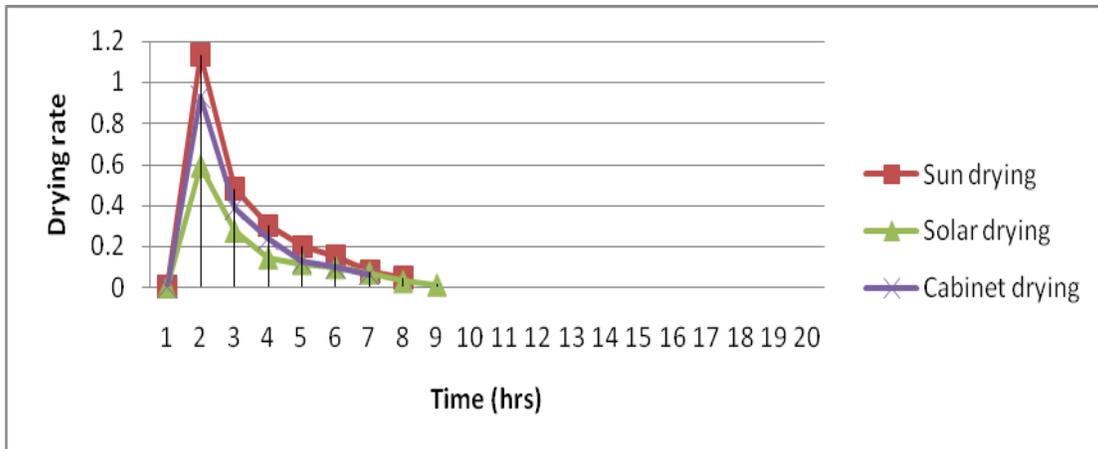
**Fig.13** Representative graph of Texture Profile Analysis (TPA) of aonla candy
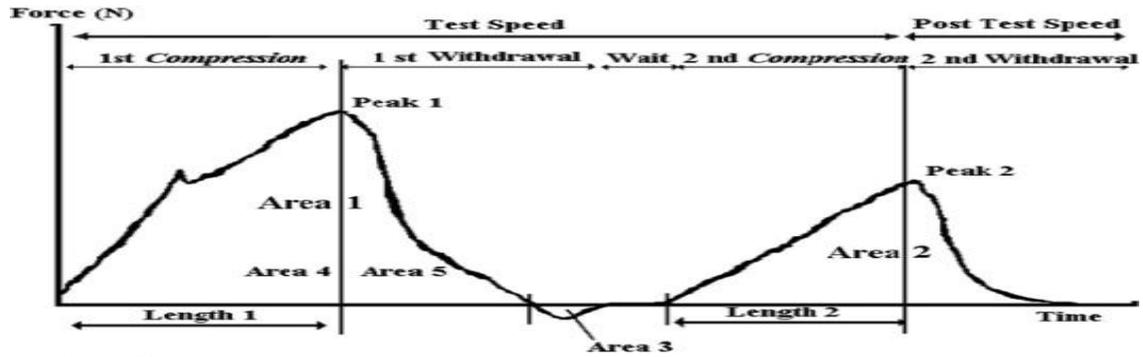


Hardness (kg) = F1
Cohesiveness = A2/A1
Adhesiveness (kg-sec) = A3
Gumminess (kg) = Hardness X Cohesiveness
Springiness = L2 / L1
Where, F1- Positive Peak Force (Cycle 1)
F2- Peak Force (Cycle 2)
A1- Positive Area (Cycle 1)
A2- Positive Area (Cycle 2)
A3- Peak Negative Force
L1 – Length of Cycle 1
L2 – Length of Cycle 2

**Fig.14** TPA graph aonla candy ($S_1T_1M_1$)
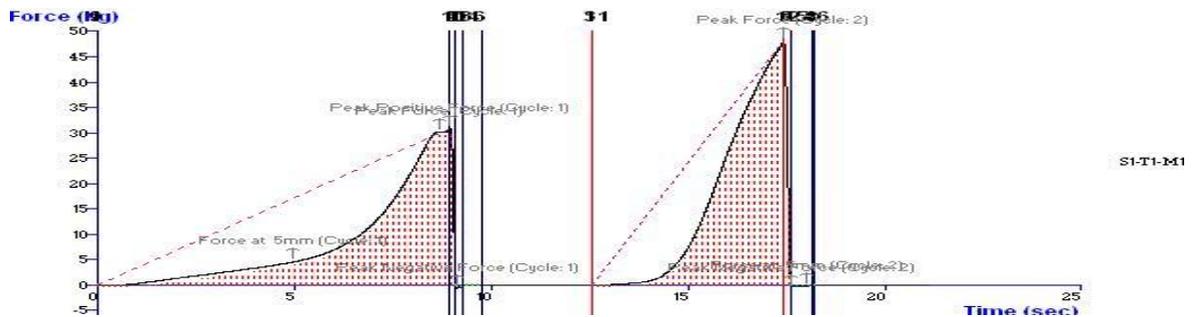


**Fig.15** TPA graph aonla candy ($S_1T_1M_2$)
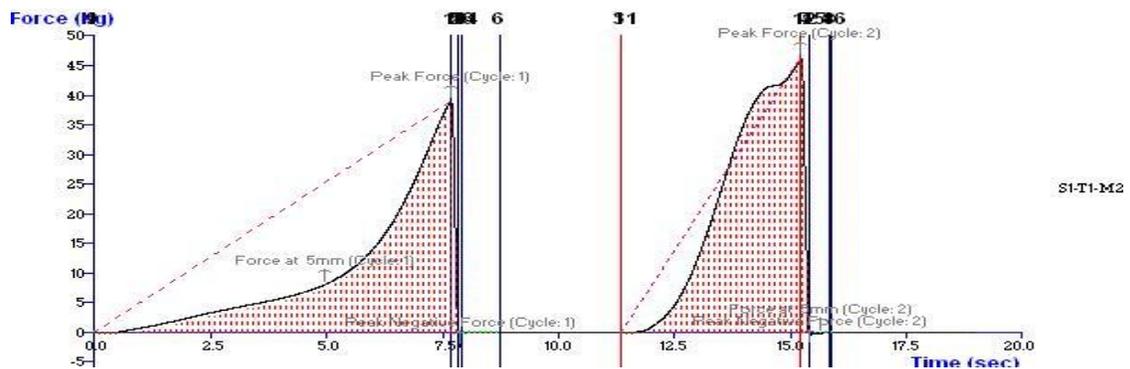
**Fig.16** TPA graph aonla candy (S₁T₁M₃)
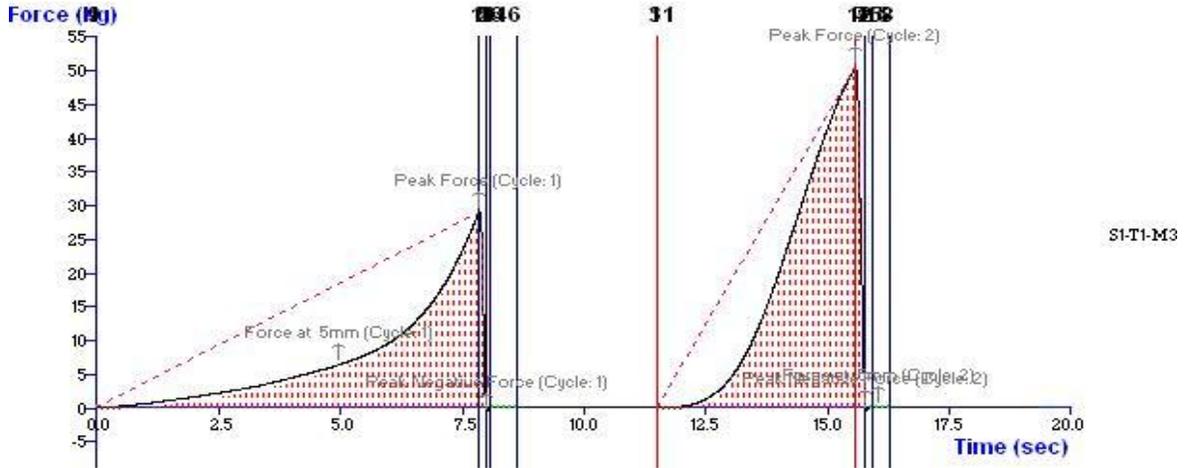


**Fig.17** TPA graph aonla candy (S₁T₂M₁)
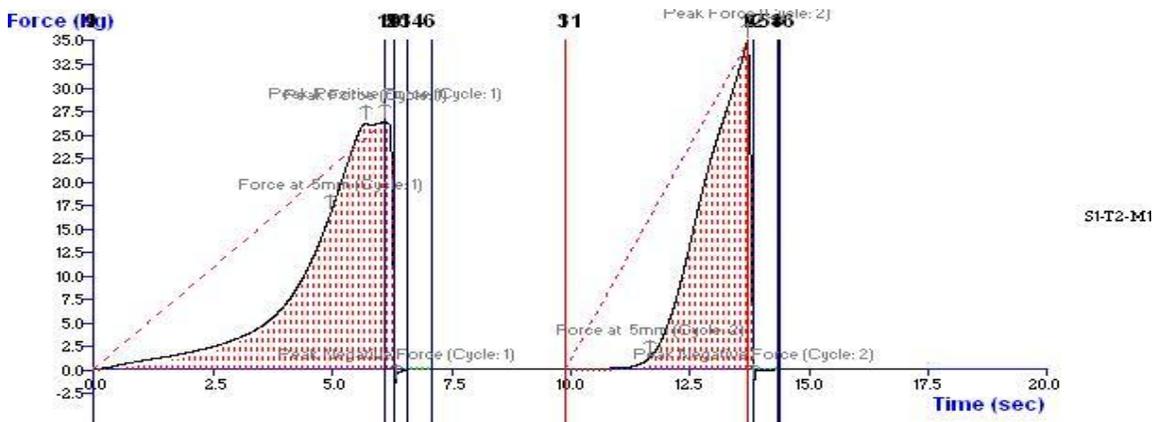


**Fig.18** TPA graph aonla candy (S₁T₂M₂)
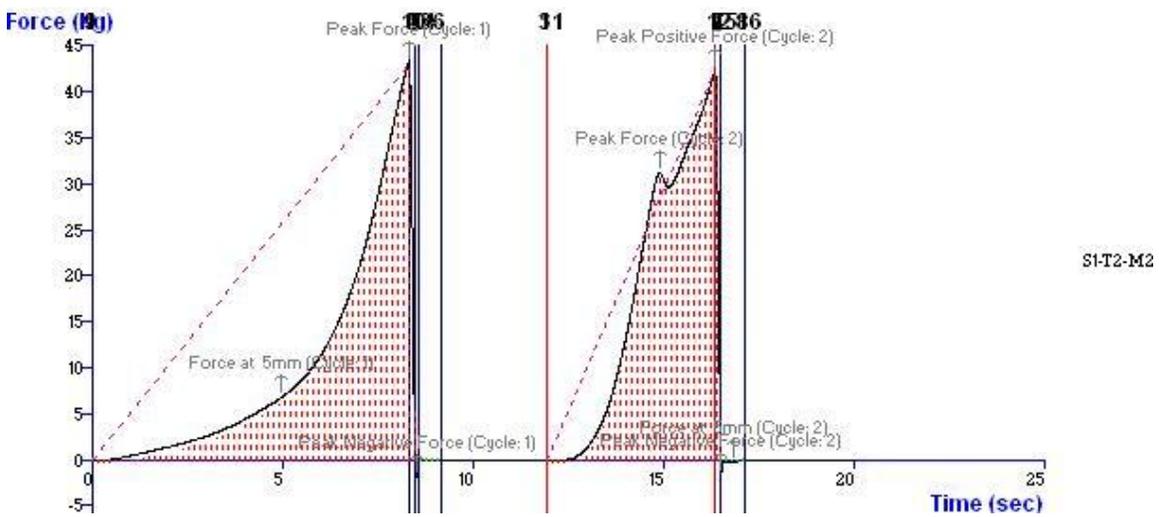
**Fig.19** TPA graph aonla candy ($S_1T_2M_3$)
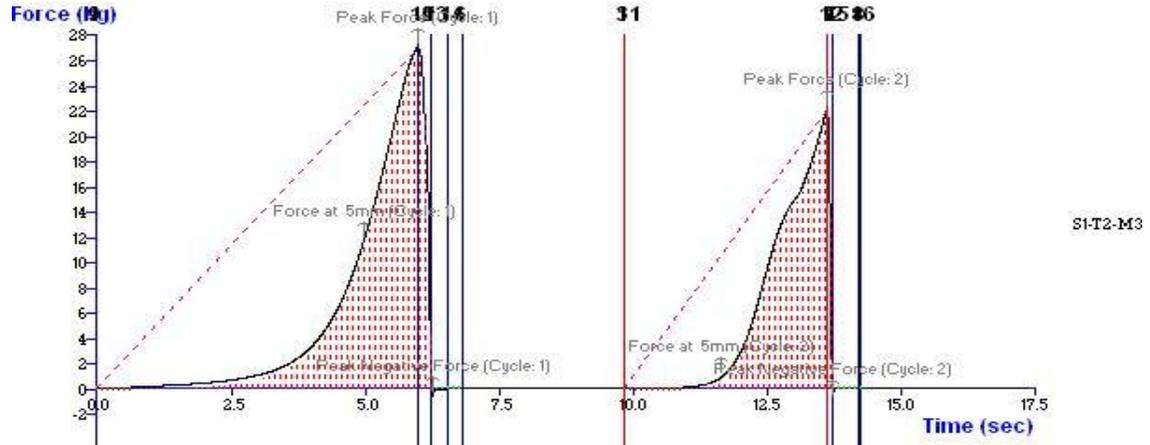


**Fig.20** TPA graph aonla candy ($S_1T_3M_1$)
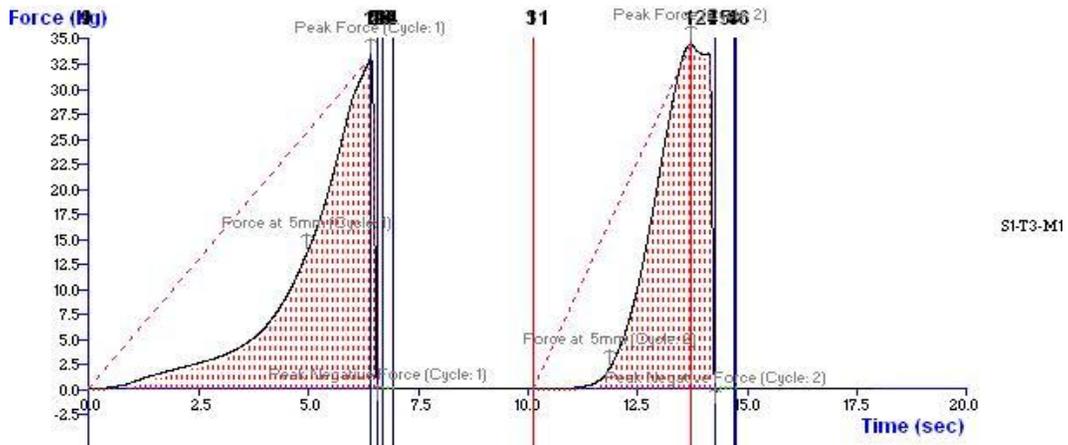


**Fig.21** TPA graph aonla candy ($S_1T_3M_2$)
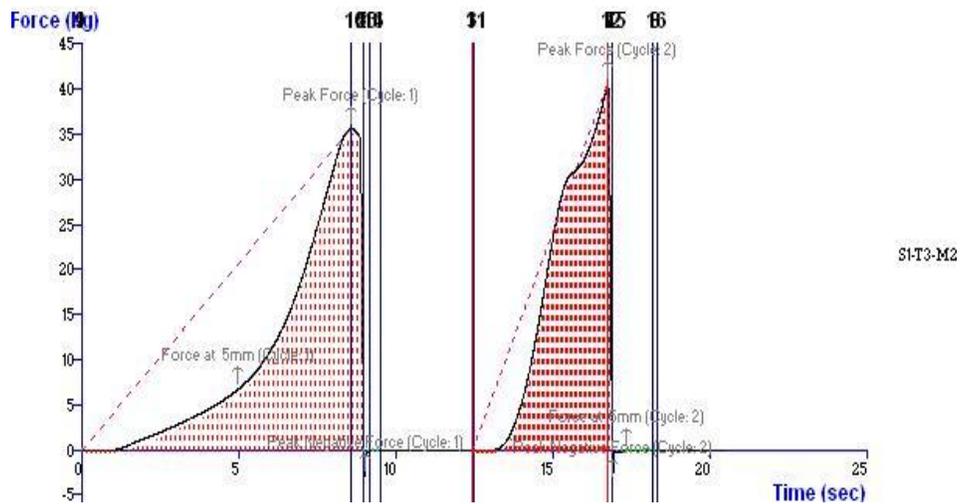
**Fig.22** TPA graph aonla candy (S$_1$T$_3$M$_3$)
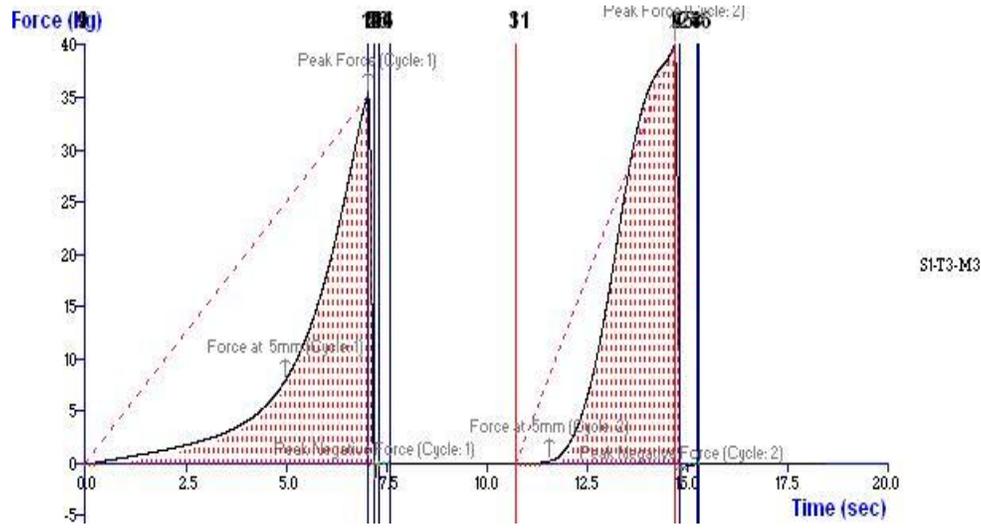


**Fig.23** TPA graph aonla candy (S$_2$T$_1$M$_1$)
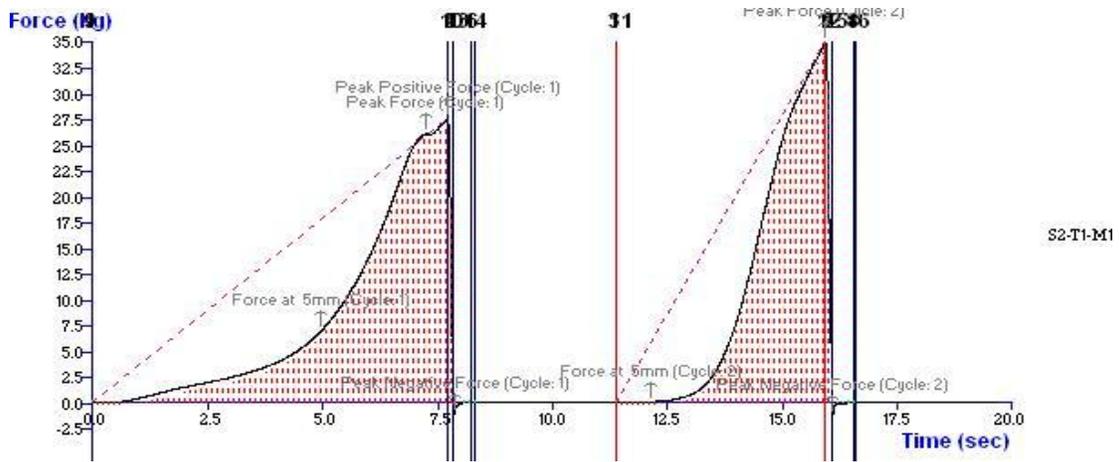


**Fig.24** TPA graph aonla candy (S$_2$T$_1$M$_2$)
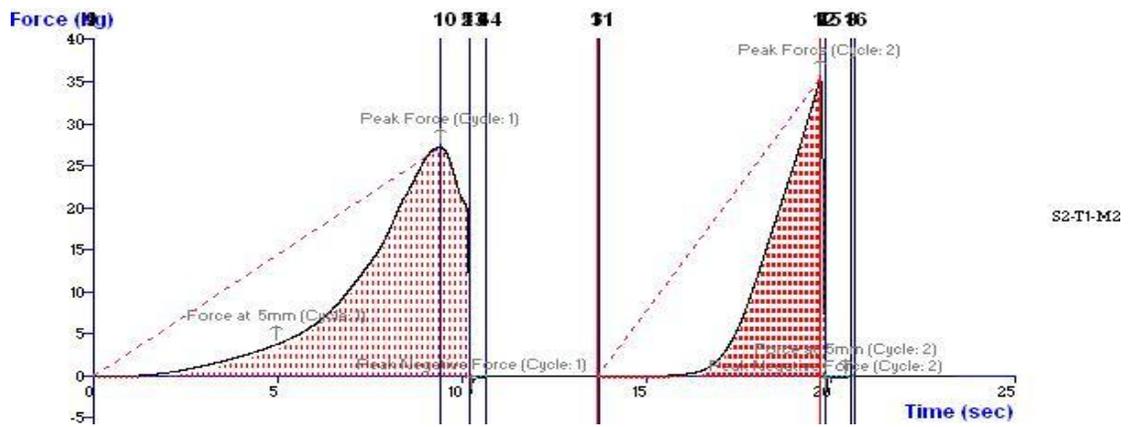
**Fig.25** TPA graph aonla candy ($S_2T_1M_3$)
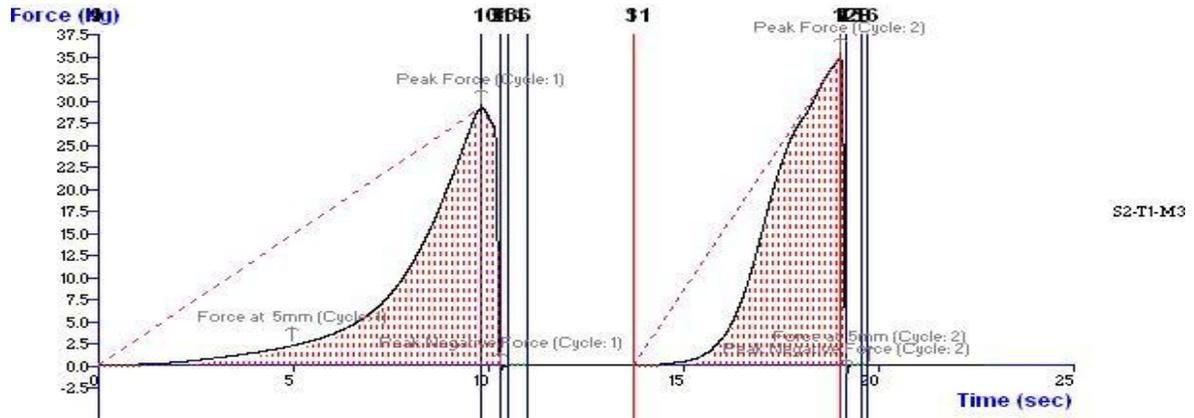


**Fig.26** TPA graph aonla candy ($S_2T_2M_1$)
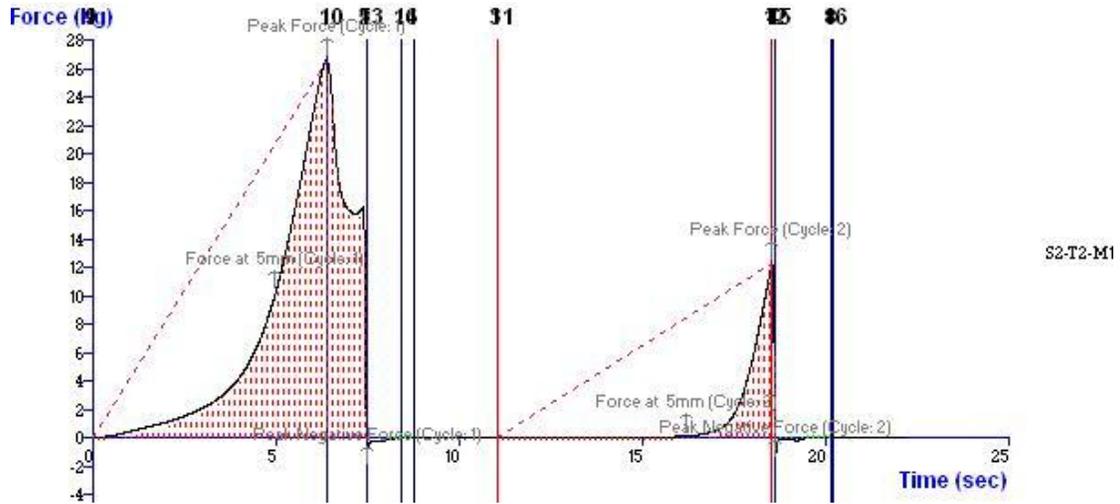


**Fig.27** TPA graph aonla candy ($S_2T_2M_2$)
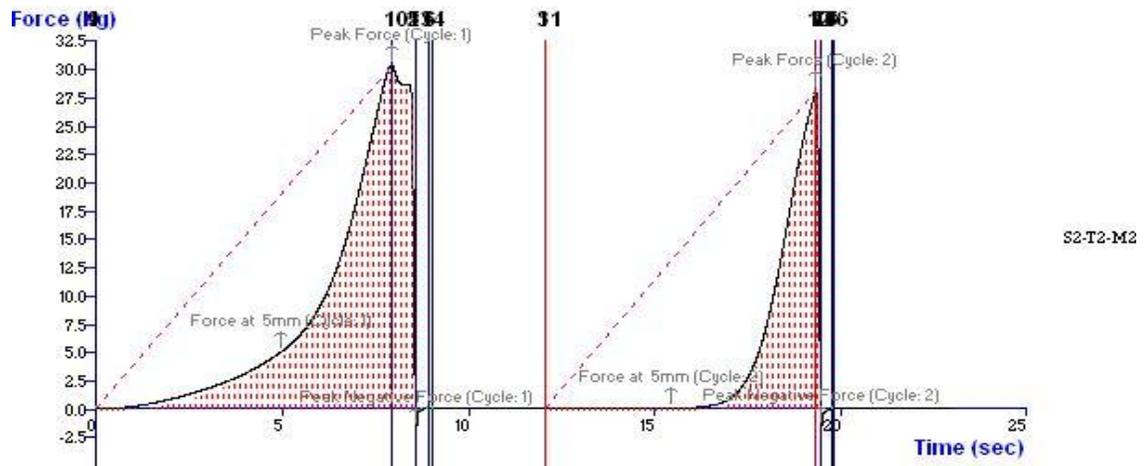
**Fig.28** TPA graph aonla candy ($S_2T_2M_3$)
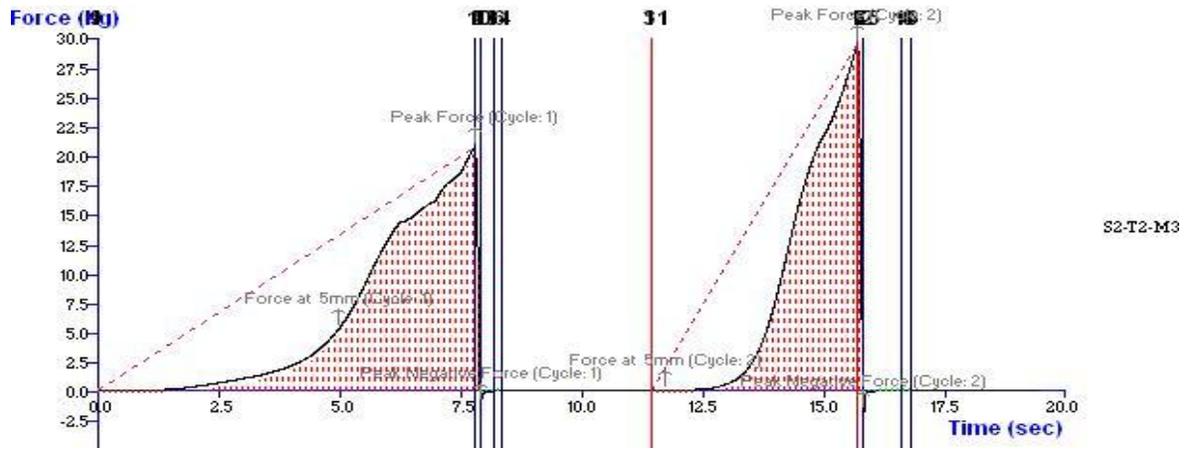


**Fig.29** TPA graph aonla candy ($S_2T_3M_1$)
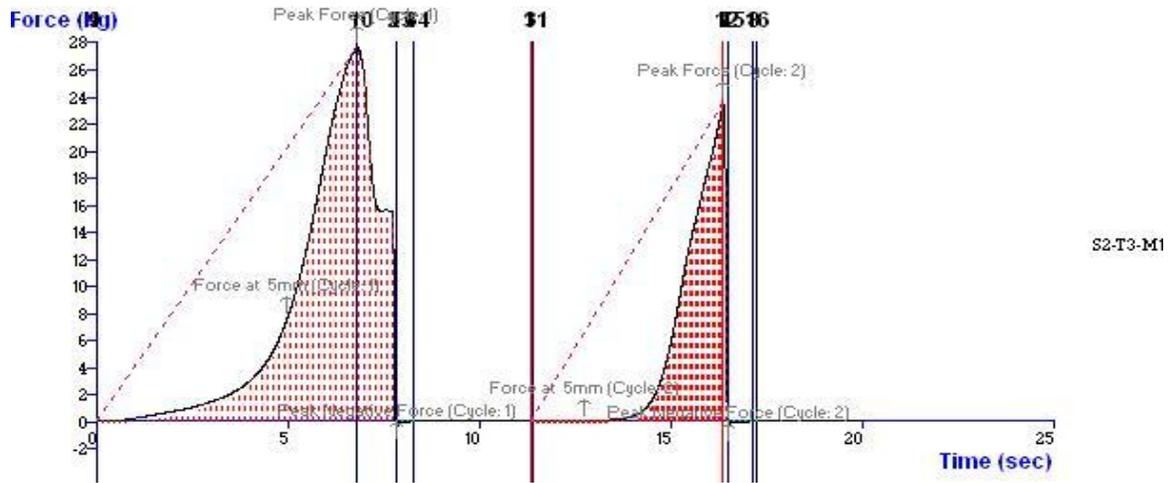


**Fig.30** TPA graph aonla candy ($S_2T_3M_2$)
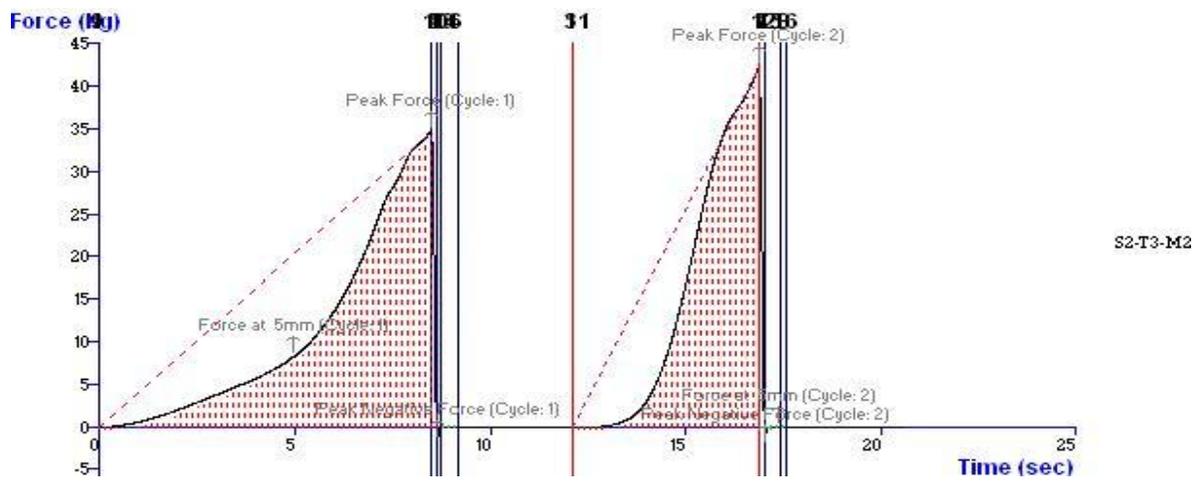
**Fig.31** TPA graph aonla candy ($S_2T_3M_3$)
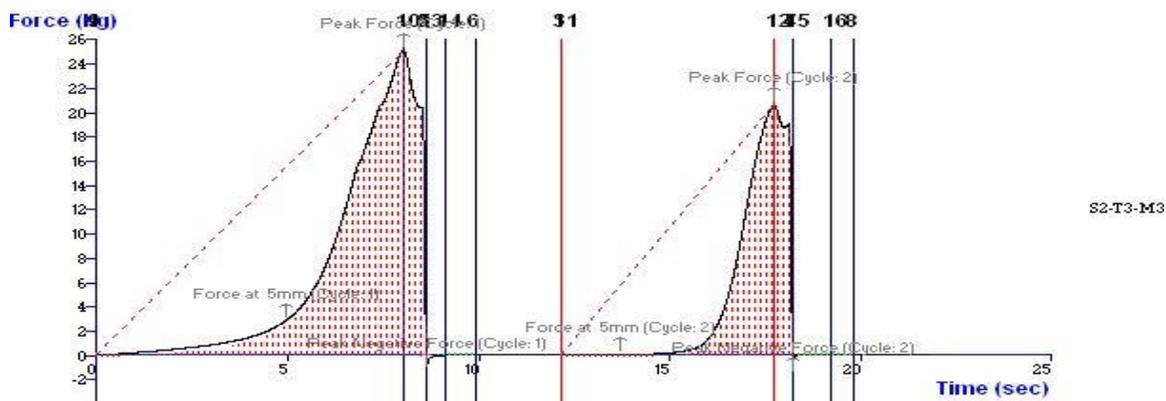


**Table.1** Effect of different treatments on Textural Profile of aonla candy

| Treatment | Hardness (kg) | Cohesiveness | Springiness | Gumminess (kg) | Adhesiveness (kg) |
|---|---|---|---|---|---|
| $S_1T_1M_1$ | 30.955 | 1.106 | 1.153 | 34.979 | 0.089 |
| $S_1T_1M_2$ | 39.166 | 1.134 | 1.165 | 44.492 | 0.115 |
| $S_1T_1M_3$ | 29.088 | 1.384 | 1.161 | 40.258 | 0.037 |
| $S_1T_2M_1$ | 26.332 | 0.748 | 1.130 | 19.696 | 0.110 |
| $S_1T_2M_2$ | 43.278 | 0.969 | 1.158 | 41.936 | 0.083 |
| $S_1T_2M_3$ | 26.972 | 0.655 | 1.130 | 17.667 | 0.070 |
| S1T3M1 | 32.999 | 0.899 | 1.127 | 29.666 | 0.042 |
| S1T3M2 | 35.785 | 0.812 | 1.172 | 29.058 | 0.150 |
| S1T3M3 | 35.284 | 1.141 | 1.148 | 40.259 | 0.078 |
| S2T1M1 | 27.618 | 0.834 | 1.137 | 23.033 | 0.102 |
| S2T1M2 | 27.308 | 0.603 | 1.135 | 16.467 | 0.203 |
| S2T1M3 | 29.161 | 0.991 | 1.160 | 28.899 | 0.071 |
| S2T2M1 | 26.627 | 0.140 | 0.996 | 3.728 | 0.297 |
| S2T2M2 | 30.353 | 0.436 | 1.048 | 13.234 | 0.139 |
| S2T2M3 | 20.720 | 0.842 | 1.151 | 17.446 | 0.103 |
| S2T3M1 | 27.577 | 0.407 | 1.118 | 11.224 | 0.120 |
| S2T3M2 | 34.803 | 0.795 | 1.148 | 27.668 | 0.083 |
| S2T3M3 | 25.101 | 0.495 | 1.101 | 12.425 | 0.156 |
| **Mean** | 30.507 | 0.801 | 1.130 | 25.119 | 0.114 |

Each value is an average of three determinations

**Details of treatments**

| Factor A(S)-Standard of Sugar Syrup | Factor B(T) Dipping Time | Factor C(M) Drying Methods |
|---|---|---|
| **S1-60%** | T1-36hrs | M1-Sun drying |
| **S2-70 %** | T2-42hrs | M2-Solar drying |
| | T3-48hrs | M3-Cabinet drying |

### Procurement of raw material

| Treat. No. | Treatment Combination | Treatment Details |
|---|---|---|
| $T_1$ | $S_1T_1M_1$ | 60% Sugar conc.+ dipping for 36 hrs + sun drying |
| $T_2$ | $S_1T_1M_2$ | 60% Sugar conc.+ dipping for 36 hrs + solar drying |
| $T_3$ | $S_1T_1M_3$ | 60% Sugar conc. + dipping for 36 hrs + cabinet drying |
| $T_4$ | $S_1T_2M_1$ | 60% Sugar conc.+ dipping for 42 hrs + sun drying |
| $T_5$ | $S_1T_2M_2$ | 60% Sugar conc. + dipping for 42 hrs + solar drying |
| $T_6$ | $S_1T_2M_3$ | 60% Sugar conc. + dipping for 42hrs + cabinet drying |
| $T_7$ | $S_1T_3M_1$ | 60% Sugar conc. + dipping for 48hrs + sun drying |
| $T_8$ | $S_1T_3M_2$ | 60% Sugar conc. + dipping for 48hrs + solar drying |
| $T_9$ | $S_1T_3M_3$ | 60% Sugar conc. + dipping for 48hrs + cabinet drying |
| $T_{10}$ | $S_2T_1M_1$ | 70% Sugar conc. + dipping for 36 hrs + sun drying |
| $T_{11}$ | $S_2T_1M_2$ | 70% Sugar conc. + dipping for 36 hrs + solar drying |
| $T_{12}$ | S2T1M3 | 70% Sugar conc. + dipping for 36 hrs + cabinet drying |
| $T_{13}$ | $S_2T_2M_1$ | 70% Sugar conc. + dipping for 42 hrs + sun drying |
| $T_{14}$ | $S_2T_2M_2$ | 70% Sugar conc. + dipping for 42 hrs + solar drying |
| $T_{15}$ | $S_2T_2M_3$ | 70% Sugar conc. + dipping for 42 hrs + cabinet drying |
| $T_{16}$ | $S_2T_3M_1$ | 70% Sugar conc. + dipping for 48 hrs + sun drying |
| $T_{17}$ | $S_2T_3M_2$ | 70% Sugar conc. + dipping for 48 hrs + solar drying |
| $T_{18}$ | $S_2T_3M_3$ | 70% Sugar conc. + dipping for 48 hrs + cabinet drying |

Cohesiveness refers to the strength of internal bonds that keeps the sample cohesive. The lowest value of cohesiveness (0.140) was observed in treatment $S_2T_2M1$ (70% sugar syrup concentration, 48 hr. dipping time and sun dryer) followed by in treatment $S_2T3M_1$ (70% sugar syrup concentration, 48 hours. dipping time and sun dryer) i.e. 0.407 whereas treatment $S_1T_1M_3$ (60% sugar syrup concentration, 36 hr. dipping time and cabinet drying) showed highest value of cohesiveness (1.384). The mean value of cohesiveness of aonla candy was 0.801.

Springiness is how well a product physically springs back after it has been deformed during the first compression. The highest springiness value (1.172) was found in $S_1T_3M_2$ (60% sugar syrup concentration, 48 hr. dipping time and solar dryer), whereas the least in $S_2T_2M_1$ (70% sugar syrup concentration, 42 hr. dipping time and sun drying) i.e. 0.996.The

mean value of springiness of aonla candy was 1.130.

Moreover, adhesiveness was found to be highest in treatment $S_2T_2M_1$ (0.297) whereas the least adhesiveness was found in treatment $S_1T_1M_3$ (0.037).

The objectives of investigation were to study the effect of concentration of sugar syrup, period of dipping and various drying methods for preparation of aonla candy. The treatment $S_1T_2M_2$ showed the highest values for hardness (43.278 kg). The hardness was found to be less in treatment $S_2T_2M_3$ (20.720 kg.). The treatment $S_2T_1M_3$ showed lowest value of cohesiveness (0.991) and treatment $S_1T_1M_1$ showed the highest value (1.106). The highest springiness value (1.172) was found in$S_1T_3M_2$ and treatment $S_2T_2M_1$ showed lowest value i.e.0.996. Moreover, adhesiveness was found to be highest in

treatment $S_2T_2M_1$) i.e. 0.297 and least in treatment $S_1T_1M_3$ i.e. 0.037.

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