

Effect of edible coating on shelf life and physico-chemical changes in Sapota (*Achras sapota* L.) cv Cricket Ball under ambient condition

ABSTRACT

A research experiment was conducted at Post-harvest Laboratory, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). The experiment was conducted to study the effect of edible coating on Shelf life and Physico-chemical changes in Sapota (*Achras sapota* L.) under ambient condition. The experiment was conducted in Factorial Completely Randomized Design with three replications. There were two factors i.e., Aloe vera Gel and cornstarch each having 4 concentrations i.e., Aloe vera gel (0%, 25%, 50% and 75%) and cornstarch (0%, 1%, 2% and 3%). Various physical and chemical parameters were observed for each treatment. Physical parameters like Weight loss (86.00 g), Fruit length (5.28 cm), fruit diameter (5.00 cm), decay percent (0.00%) and surface color values of L^* , a^* and b^* (36.16, 9.36 and 20.44) decreased minimum under Aloe vera gel (75%) and cornstarch (2%). Similarly, chemical parameters like Acidity decreased maximum (0.039%), ascorbic acid decreased minimum (8.68 mg/100g), TSS increased maximum (31.50°Brix), Total sugars increased maximum (21.60%), reducing sugar increased maximum (15.25%) and non-reducing increased maximum (6.35%) under Aloe vera gel (75%) and cornstarch (2%). As regards the individual the Aloe vera gel (75%) and cornstarch (2%) was found superior over other treatments.

Keywords: Aloe vera gel, Cornstarch, Sapota

Introduction

Post-harvest losses are serious challenge faced by fruit growers and fruit industries because of rapid deterioration during transport, handling, and storage. In tropical countries like India, post-harvest losses in sapota fruits are higher ranging from 25 to 30% (Salunkhe and Desai, 1984). These losses occur due to various factors, including a lack of insufficient storage facilities, improper handling during long-distance transportation, without pre-treatments, quick ripening, microbial deterioration etc. Therefore, it is urgent need to evolve which have an any technology with the ability to reduce the post-harvest losses. It will be benefited to the growers and consumers. Coating of edible substances in a thin film which help to keep the fruit fresh improve quality with respect to longevity and can be eaten safely. It also delays spoiling, hampered microbiological activity, and respiration rate, as well as extend the shelf life of products by limiting moisture loss and gas exchange. Edible coating is a cheaper and successful strategy that may be used at the agricultural level. The starch-based coating also found to be cost effective, bio-degradable edible coat. It is an excellent option for post-harvest packing as well as preservation for various fruits including Sapota (Dey *et al.*, 2014). Hence, these coating agents may be used for increasing self-life of fruit like Sapota. However, there is a scarcity of research work in this field. Therefore, the present study was carried out to know the effect of various coating agents on self-life and physio-chemical changes occurs in Sapota under ambient condition.

Material and Methods

An experiment was conducted in a laboratory belonging to the Laboratory of Department of Horticulture, College of Agriculture, JNKVV, Jabalpur, (M.P.) during the year 2022. The physiological matured color break stage fruits of Cricket Ball variety sapota having uniformed size and shape free from injury and pathogenic infection were harvested and cleaned with moist cloth. The fruits were treated with four levels of each, Alovera gel (0%, 25%, 50% and 75%) and cornstarch (0%, 1%, 25% and 3%) and their combinations and were replicated thrice in CRD design. The treated fruits were stored in ambient conditions and analyses after 7 days for physical and chemical properties. The TSS were recorded with hand refractometers and results were expressed as °Brix. The percent acidity was analyzed by titrating the fruit juice pulp with N/10 NaOH using phenolphthalein as an indicator. The ascorbic acid contents were determined by using 2,6 dichlorophenol indophenol dye (Ranganna, 1997). The reducing sugar and total sugars were determined by standard methods (AOAC, 1995).

Results and Discussion

The data presented in Table-1 revealed that during storage, an increase in surface colour development was observed in all treatments and minimum decrease of L* and b* values (up to 8.16% and 29.14%, respectively) whereas, minimum increase in a* value (63.56%) was recorded under fruit coated with 75% Aloe vera gel. Similarly in case of cornstarch, minimum decrease in colour values L* and b* (11.35% and 34.69%, respectively) was noted in fruits receiving cornstarch 2% coating and maximum decrease in colour L* and b* (14.86% and 39.19%, respectively) in control as compared to mean initial L* and b* values and minimum increase in a* value by 96.25% was recorded in fruits treated with 2% Cornstarch and maximum by 117% in control treatment as compared to mean initial a* value. As regards, the interaction effect minimum decrease in colour L* and b* (up to 7.19% and 27.80%, respectively) and minimum increase in color a value by 40.33% was recorded under Aloe vera gel 75% and 2% cornstarch while maximum decrease in L* and b* values (up to 23.00% and 49.59%, respectively) and maximum increase in a* value by 153.07% was observed under control after 7 days of storage in comparison to average initial L*, a* and b* values (38.96, 6.67 and 28.31). The colour of outer peel of Sapota was shifting to reddish brown. However, this colour change towards red was more in control than that of treated ones and this edible coating could prevent the Sapota fruit from becoming more reddish brown (Padmaja and Bosco, 2014; Hamman, 2008).

Table 1: Effect of edible coating of Aloe vera gel on physical parameters after 7 days under ambient condition of Sapota Fruits

Treatment	Fruit				Fruit Surface colour		
	PPWLW (%g)	Length (cm)	Diameter (cm)	Decay (%)	L* value	a* value	b* value
Aloe vera gel							
Aloe vera gel 0%	77.15	4.34	4.18	70.00	31.75	16.34	15.29
Aloe vera gel 25%	79.68	4.58	4.42	43.33	33.82	14.5	17.19
Aloe vera gel 50%	82.20	4.79	4.77	16.67	34.6	13.62	18.98
Aloe vera gel 75%	86.02	5.16	4.97	5.00	35.78	10.91	20.06
Cornstarch							
Water alone	80.43	4.61	4.49	43.33	33.17	14.54	17.21

Cornstarch 1%	81.18	4.66	4.55	36.67	33.79	14.08	17.69
Cornstarch 2%	82.23	4.81	4.65	25.00	34.54	13.09	18.49
Cornstarch 3%	81.80	4.79	4.63	30.00	34.46	13.66	18.13
For Aloevera gel and Cornstarch							
SE(m)±	0.03	0.02	0.01	4.41	0.03	0.08	0.03
C.D. at 5% level	0.11	0.06	0.03	14.11	0.10	0.24	0.11
Interaction effect of Aloevera gel and Cornstarch							
Aloevera gel 0 % + Cornstarch 0%	75.5	4.21	4.05	80.00	30.00	16.88	14.27
Aloevera gel 0 % + Cornstarch 1%	77.2	4.29	4.13	73.33	31.05	16.70	15.00
Aloevera gel 0 % + Cornstarch 2%	78.0	4.43	4.27	60.00	32.96	15.75	16.49
Aloevera gel 0 % + Cornstarch 3%	77.8	4.41	4.25	66.67	32.98	16.02	15.38
Aloevera gel 25 % + Cornstarch 0%	79.1	4.47	4.31	53.33	33.16	14.93	16.56
Aloevera gel 25 % + Cornstarch 1%	79.5	4.52	4.36	46.67	33.88	14.49	17.10
Aloevera gel 25 % + Cornstarch 2%	80.2	4.67	4.51	33.33	34.15	14.22	17.59
Aloevera gel 25 % + Cornstarch 3%	80.0	4.65	4.49	40.00	34.10	14.37	17.51
Aloevera gel 50 % + Cornstarch 0%	81.8	4.75	4.72	26.67	34.22	14.03	18.44
Aloevera gel 50 % + Cornstarch 1%	82.5	4.77	4.76	20.00	34.54	13.88	18.75
Aloevera gel 50 % + Cornstarch 2%	83.6	4.80	4.80	6.67	34.88	13.03	19.43
Aloevera gel 50 % + Cornstarch 3%	83.4	4.82	4.78	13.33	34.77	13.53	19.31
Aloevera gel 75 % + Cornstarch 0%	85.3	4.99	4.89	13.33	35.29	12.30	19.58
Aloevera gel 75 % + Cornstarch 1%	85.6	5.06	4.96	6.67	35.67	11.25	19.91
Aloevera gel 75 % + Cornstarch 2%	87.2	5.32	5.03	0.00	36.16	9.36	20.44
Aloevera gel 75 % + Cornstarch 3%	86.0	5.28	5.00	0.00	36.00	10.71	20.32
SE(m)±	0.07	0.04	0.02	8.82	0.06	0.15	0.07
C.D. at 5% level	0.21	0.12	0.07	28.21	0.20	0.48	0.22

It is clear from the current experiments that weight loss and reduction in size throughout the 7-day storage period was considerably impacted by various post-harvest treatments and

minimum losses in fruit weight (5.37%) and size (length 8.83% and diameter 7.79%) was recorded at 7th day of storage in comparison to average initial value under when fruit coated with 75% Aloe vera gel. This result is in agreement with the behaviour of stand-alone formed films, the lowest physiological loss in weight was noted in the fruits coated with 75% Aloe vera gel whereas the highest PLW was noted in uncoated fruits. Aloe vera gel, which is primarily composed of polysaccharides, was also highly effective as a moisture barrier without the addition of lipids (Ni *et al.*, 2004). The concentration of cornstarch had significantly minimized the loss in fruit weight and size during initial to 7th day of storage period and the minimum loss in weight (9.55%) and size terms of length (15.10%) and diameter (13.68%) was recorded when fruits coated with cornstarch (2%) whereas, it was maximum under control. Fruits coated with cornstarch had less weight loss during storage as compared to fruits under control. The reduction in weight and size of fruit during storage period due to shrinking of fruits occurs due to transpiration process. Similarly, Olusola and Oluwaseun (2013). Observed that cornstarch coated cucumber showed a significant delay in weight loss compared to uncoated ones. In general, physiological loss in weight increases with the advancement of storage period. In the present investigation, the minimum physiological loss in fruit weight (4.11%) fruit length (6.01%) and diameter (6.68%) was noted at 7th day during storage under Aloe vera gel (75%) and cornstarch (2%) whereas this value was maximum under control in comparison to average initial value. The possible reason for minimized weight loss by chemical might be due to evaporation and transpiration processes. The reduction in weight loss was probably due to the effects of these coatings as a semi permeable barrier against oxygen, carbon dioxide, moisture and solute movement, thereby reducing respiration, water loss and oxidation reaction rates (Baldwin *et al.*, 1999). The minimum fruit shrinking observed under fruit coated with Aloe vera gel and cornstarch might be due to the anti-senescent action of coatings which had an inhibitory effect on ethylene biosynthesis and retard the activity of enzymes responsible for ripening, cell degradation was prevented which in turn facilitated reduced moisture loss and slow down the respiratory gas exchange, hence delay in senescence and lower the shrinkage percentage (Sudha *et al.*, 2007).

The fruit decaying was significantly influenced by various post-harvest treatments. The decay (%) was minimum (5.00%) under treatment Aloe vera gel (75%) at the 7th day of storage. Aloe vera gel contains anthraquinone glycosides, glycol-proteins, gamma-lanoline acids and mucopolysaccharides that are mainly responsible for the antiviral, antibacterial as well as its antiviral antifungal activity which is the mechanism behind such positive effects of Aloe vera gel. The finding is in closely supported with Ahmed *et al.* (2009). In case of concentration of cornstarch minimum fruit decay (25.00%) was recorded under coating of cornstarch (2%) whereas, maximum fruit decay (43.33%) occurred under uncoated. Fruit decay loss is one of the salient observations in the quality of fruit and existence of decaying unfavourably affects the shelf-life of fruits. However, minimum decayed of fruits was recorded at 7th day of storage under Cornstarch (2%) and Aloe vera gel (75%) than the others. The decayed of fruits were noted about 80.00% under control. The decay percent of sapota fruits was notably affected by different edible coatings. It might be due coating reduction in water losses and decay loss has been increased continuously with the advancement of storage period. Wang *et al.*, (2019) reported that the packaging materials could reduce water loss to a certain extent to avoid strawberry oxidation and reduce respiration, reducing the chance of fungal infection and decaying.

The significantly higher values of TSS (30.98^{0B}) was recorded under 75% Alovera gel whereas it was minimum (24.21^{0B}) under control at the 7th day of storage period. As the storage period progresses, fruits coated with Alovera gel (75%) recorded higher TSS value due to rapid breakdown of pectin and carbohydrates. This trend is in close agreement with Jholgikar and Reddy (2007). In the case of concentration of cornstarch, maximum increase in the value of TSS (28.68^{0B}) whereas, minimum under control (27.11^{0B}) were recorded as against the initial TSS value of 20.21^{0B} . Among the different combination of Alovera gel and cornstarch the maximum value of 31.50^{0B} was noted when fruits coated with Alovera gel (75%) in combination of cornstarch (2%) whereas it was minimum (23.50^{0B}) under control at the last day of storage period. The rise in TSS is mainly due to hydrolysis of starch and sugars starts accumulating and mainly because of progressive boosting of free sugars and lowest TSS was recorded in coated fruits due to slow breakdown of carbohydrates and pectin under modified atmosphere which reduced respiration and transpiration rate in coated fruits (Yaman and Bayoindirli, 2002)

Acidity was significantly influenced by various post-harvest treatments in comparison to initial value of (0.041%) after 7th day of storage period and minimum decreased by 29.27% (0.029%) under fruit coated with Alovera gel 50 and 75 per cent), whereas maximum by 60.97% (0.016%) observed under control. In case of concentration of cornstarch, minimum decrease in acidity by 31.71% (0.028%) whereas, maximum decrease in acidity by 43.90% (0.023%) under uncoated fruits with cornstarch. As regards the combine application of Alovera gel and cornstarch significant effect on acidity was noted and minimum decreased by 14.63% with value of 0.035% was recorded under fruit coated with Alovera gel (75%) with cornstarch (1%) however, Alovera gel 75% with all levels of cornstarch were noted at par with each other's. The lower level of acidity in the control may be attributed due to its utilization in respiration compared to the coated fruits. The results are line with Damodaran *et al.*, (2001).

Data revealed that ascorbic acid reduced with the increase in storage period in all the treatments from the initial value of 14.31 mg/100g. The maximum value of ascorbic acid (8.53 mg/100g) as well as minimum reduction in terms of percentage (40.39%) was recorded under fruit coated with Alovera gel (75%). Similar trend was noted when fruit coated with cornstarch at the 7th day of storage period. The ascorbic acid content reduces continuously under all the treatments with the time period of storage. As regard the combined effect of Alovera gel and cornstarch had showed significant effect and maximum value ascorbic acid of 8.68 mg/100g was noted with minimum reduction (39.34%) when fruit coated with Alovera gel (75%) in combination of 2% cornstarch. There was reduction in ascorbic acid in the uncoated fruits throughout period of ripening. There was significant increase in ascorbic acid content in coated fruits at the end of ripening as compare to control. This could be attributed to slower rate of oxidation of ascorbic acid in all the treatment Gautam and Chundawat (1989).

The data presented in Table -2, revealed that the all the treatment showed significant effect on percentage of total sugar, reducing sugar and non-reducing sugar and maximum value of 19.05, 14.50 and 6.18 % was recorded at the end of 7th of storage period under coating of Alovera gel (75%), respectively. As regard to coating of corn starch showed similar trend and maximum value of total sugar (19.05%), reducing sugar (13.94) and non-reducing sugar (5.11 %) was noted when fruit coated with 2% cornstarch. Similarly, the fruit coated with Alovera gel and cornstarch had also showed significant effect and maximum value of total sugar (21.60%),

reducing sugar (15.25%) and non-reducing sugar (6.35%) were recorded under cornstarch (2%) + Aloe vera gel (75%) along with cornstarch (2%) and this value was minimum under untreated fruits at the end of storage period. However, total sugar levels significantly increased during fruit storage in all treatments except control, as storage accelerated respiration and transpiration rates and inhibited the enzymatic activity that breaks down sugars. The subsequent decline may have resulted from the use of sugars for respiration, these findings are supported by the observations of Mohamed *et al.* (2013) in prickly pear. With the extension of storage time, polysaccharides hydrolyse into mono and disaccharides, which may result in a rise in TSS and sugars. Due to the fact that polysaccharides are the main substrate for respiration, after they have completely hydrolysed, no further growth takes place, and a subsequent drop in the parameters is expected. Chacon *et al.* (2017) in tomato and Minh *et al.*, (2019) in capsicum both found similar results. The increase in non-reducing sugar was due to the conversion of starch into sugar during storage. The findings in the present investigation were obtained similar in Ber (Bhowmik *et al.*, 2015) and in guava (Singh *et al.*, 2018).

Table 2: Effect of edible coating of Aloe vera gel on Bio-chemical Parameters after 7 days under ambient condition of Sapota Fruits

Treatments	TSS (° Brix)	Acidity (%)	Ascorbic acid (mg/100g)	Total Sugar (%)	Reducing Sugar (%)	Non-reducing sugar (%)
Aloe vera gel						
Aloe vera gel 0%	24.21	0.016 (60.98)	7.48 (47.73)	16.01	11.95	4.06
Aloe vera gel 25%	26.98	0.022 (46.34)	7.98 (44.23)	17.46	13.07	4.40
Aloe vera gel 50%	29.60	0.029 (29.27)	8.28 (42.14)	19.54	14.50	5.04
Aloe vera gel 75%	30.98	0.029 (29.27)	8.53 (40.39)	21.16	14.98	6.18
Cornstarch						
Water alone	27.11	0.023 (43.90)	7.95 (44.44)	17.97	13.23	4.74
Cornstarch 1%	27.48	0.024 (41.46)	8.04 (43.82)	18.35	13.55	4.80
Cornstarch 2%	28.68	0.028 (31.71)	8.19 (42.77)	19.05	13.94	5.11
Cornstarch 3%	28.50	0.027 (34.15)	8.09 (43.47)	18.80	13.77	5.03
For Aloe vera gel and Cornstarch						
SE(m)±	0.02	0.001	0.04	0.04	0.05	0.05
C.D. at 5% level	0.06	0.003	0.14	0.12	0.15	0.17
Interaction effect of Aloe vera gel and Cornstarch						
Aloe vera gel 0% + Cornstarch 0%	23.50	0.014 (65.85)	7.32	15.25	11.29	3.96

			(48.85)			
Aloevera gel 0 % + Cornstarch 1%	24.10	0.015 (63.41)	7.48 (47.73)	16.06	12.06	4.00
Aloevera gel 0 % + Cornstarch 2%	24.70	0.018 (56.10)	7.63 (46.68)	16.52	12.35	4.17
Aloevera gel 0 % + Cornstarch 3%	24.50	0.017 (58.54)	7.50 (47.59)	16.21	12.10	4.11
Aloevera gel 25 % + Cornstarch 0%	25.40	0.020 (51.22)	7.86 (45.07)	16.85	12.56	4.29
Aloevera gel 25 % + Cornstarch 1%	25.70	0.021 (48.78)	7.91 (44.72)	17.12	12.79	4.33
Aloevera gel 25 % + Cornstarch 2%	28.50	0.025 (39.02)	8.10 (43.40)	18.07	13.56	4.51
Aloevera gel 25 % + Cornstarch 3%	28.30	0.024 (41.46)	8.03 (43.89)	17.81	13.36	4.45
Aloevera gel 50 % + Cornstarch 0%	29.10	0.027 (34.15)	8.19 (42.77)	19.02	14.37	4.65
Aloevera gel 50 % + Cornstarch 1%	29.40	0.028 (31.71)	8.26 (42.28)	19.22	14.43	4.79
Aloevera gel 50 % + Cornstarch 2%	30.00	0.032 (21.95)	8.35 (41.65)	20.00	14.61	5.39
Aloevera gel 50 % + Cornstarch 3%	29.90	0.031 (24.39)	8.30 (42.00)	19.90	14.58	5.32
Aloevera gel 75 % + Cornstarch 0%	30.40	0.034 (17.07)	8.41 (41.23)	20.75	14.70	6.05
Aloevera gel 75 % + Cornstarch 1%	30.70	0.035 (14.63)	8.49 (40.67)	21.00	14.92	6.08
Aloevera gel 75 % + Cornstarch 2%	31.50	0.039 (14.88)	8.68 (39.34)	21.60	15.25	6.35
Aloevera gel 75 % + Cornstarch 3%	31.30	0.038 (14.73)	8.53 (40.39)	21.28	15.05	6.23
SE(m)±	0.03	0.002	0.09	0.09	0.10	0.10
C.D. at 5% level	0.11	0.008	0.28	0.27	0.31	0.33

Figure in parenthesis indicated percentage reduction form initial values

References

AhmedMJ., Singh Z.,& Khan AS.(2009). Postharvest Aloevera gel□coating modulates fruit ripening and quality of 'Arctic Snow 'nectarine kept in ambient and cold storage. *International Journal of Food Science & Technology*, 44(5): 1024-1033.

- AOAC. (1995). Official Methods of Analysis (6th Edn.) Association of official Agricultural Chemists, Washington, D.C.
- Baldwin EA., Burns JK., Kazokas W., Brecht JK., Hagenmaier RD., Bender RJ., & Pesis E. (1999). Effect of two edible coatings with different permeability characteristics on mango (*Mangifera indica* L.) ripening during storage. *Postharvest Biol. Technol.*, 17: 215-226.
- Bhowmick N., Dey K., Ghosh A., & Ghosh A. (2014). Physico-chemical properties of sapota (*Manilkaraachras* (Mill) Fosb.) fruits coated with cornstarch. *J. Crop Weed*, 10:43-49.
- Chacon X., Contreras JC., Montañez J., Aguilera-Carbo A.F., & Reyes-Vega M L. (2017). Guar gum as an edible coating for enhancing shelf-life and improving post-harvest quality of Roma tomato (*Solanumlycopersicon* L.) *J. Food Q.* 1(17): 115-124.
- Chundawat BS., & Bhuva HP. (1982). Performance of some cultivars of sapota (*Achras sapota* L.) in Gujarat. *Haryana Journal of Horticulture Sciences*, 11 (3-4): 154-158.
- Damodaran T., Attri BL., Medhi RP., Nair SA., & Alex L. (2001). Studies on post-harvest management of sapota (*Achras zapota*) cv. 'Cricket Ball' during storage. *Indian J. Hort.*, 58 (4): 342-45.
- Dey K., Ghosh A., Bhowmick N., & Ghosh A. (2014). Physico-chemical properties of sapota (*Manilkaraachras* (Mill) Fosb.) fruits coated with cornstarch. *J. Crop Weed*, 10:43-49.
- Hamman JH. (2008). Composition and Applications of Aloe vera Leaf Gel. *Molecules* 13: 1599-1616.
- Jhologiker P., & Reddy BS. (2007). Effect of different surface coating material on postharvest physiology of *Annona squamosa* L. fruits under ambient and zero energy cool chamber storage. *Indian Journal of Horticulture*, 64(1): 41-44.
- Minh N., Pham V., Tuan T., To T., & Mai D. (2019). Application of guar gum as edible coating to prolong shelf-life of red chilli pepper (*Capsicum frutescens* L.) fruit during preservation. *J. Pharm. Sci. Res.* 11(4): 1474-1478.
- Ni Y., Turner D., Yates K.Á., & Tizard I. (2004). Isolation and characterization of structural components of Aloe vera, *International Immunopharmacology*, 4(14): 1745-1755.
- Olusola A., & Oluwaseun Y. (2013). An appraisal of the impact of information technology (IT) on Nigeria small and medium enterprises (SMEs) performance. *International Journal of Academic Research in Management* 2:140-152.
- Padmaja N., & Bosco, S.D. 2014. Preservation of sapota (*Manilkara zapota*) by edible Aloe vera gel coating to maintain its quality. *Food Science*, 3(8): ISSN No 2277 -8179
- Ranganna. (1997). Analysis of fruit and vegetable products. Tata McGraw Hill Publish Co., Ltd. New Delhi, pp. 141-60.

Romero MD., Albuquerque N., Valverde JM., Guillén F., Castillo S., Valero D., & Serrano M. (2006). Postharvest sweet cherry quality and safety maintenance by Aloe vera treatment: a new edible coating. *Postharvest Biology and Technology*, 39(1): 93-100.

Formatted: Highlight

Comment [VK1]: Did not cited in the text. Correct it.

Formatted: Highlight

- Salunkhe DK.,& Desai BB. (1984). Post-harvest biotechnology of fruits. CRC Press, Inc. Bara Raton, Florida, USA 2, pp: 145-151.
- Singh B., Bhooriya M., Bisen B.,& Pandey S. (2018). Effect of post-harvest treatments on shelf life and quality of guava (*Psidium guajava* L.) fruits. *Intern. J. Chemical Studies*. 6(4): 2559-2564.
- Sudha M L., Baskaran V. &Leelavathi K. (2007). Apple pomace as a source of dietary fiber and polyphenols and its effect on the rheological characteristics and cake making. *Food Chemistry*, 104 (2): 686-692.
- Wang S., Nadin MA., Zhou X., Jiang L., Ridings A., Knott D., Wei F., Yuan J., Altman E., Gao Y.,&Miao J. (2018). Evaluation of extracts prepared from 16 plants used in Yao ethnomedicine as potential anticancer agents. *J Ethnopharmacol*, 211:224–234.
- Yaman O.,&Bayoindirli L. (2002). Effects of an edible coating and cold storage on shelf life and quality of cherries. *LWT-Food science and Technology*, 35(2): 146-150.

UNDER PEER REVIEW