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Development of Novel Products from Osmo-Dried Apples: Apple Choco Shots and Apple Pie

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A B S T R A C T

Novel products were prepared from apple fruits by using osmotic dehydration. In the present study osmo-dried apple pops and rings were developed from '*Golden delicious*' apples and further utilized for the development of novel products viz. apple choco shots and apple pie. The technology for osmo-dried apple pops with diameter of 28 mm and apple rings with thickness of 0.5 cm, followed by dipping in sugar syrup and honey for four hours at 50^{o}C was optimized. Honey osmo-dried apple pops and rings were found better in terms of quality and sensory characteristics and having less water activity. Further, the novel products were prepared from osmo-dried apple pops and rings i.e. apple choco shots and apple pie. Honey being rich in phenols and flavonoids result in better antioxidant activity with excellent energy value of the developed products. The apple choco shots and apple pie prepared from honey osmo-dried pops and rings were found better in quality with energy value of 430.09 Kcal/100g and 260.74 Kcal/100g respectively. Thus, the developed technology can be commercially explored at industry level for the production of quality osmo-dried apple pops, apple rings, apple choco shots and apple pie.

Introduction

Apple (*Malus domestica*) is one of the most important temperate fruit of Himachal Pradesh and constitutes about 49 per cent of the total crop area under this fruit crop. It is cultivated in an area of 1, 10, 679 ha with a production of 7, 77, 126 MT and productivity of 7.02 MT/ha (Anonymous, 2016). With great nutritional value apple occupies a significant place in the nutritional produce of the state and plays a vital role in economy of the people. Apple contains lots of nutrients including vitamin C, potassium and fibre (Boyer and Liu, 2004). Apples are processed into a variety of products, but by far the largest volume of processed apple products is in the form of juice. Apple juice, pulp and concentrate are the major processed products in the market. However, the novel products from the apple fruits are lacking.

Apples are prone to qualitative and quantitative losses after harvest and as high as 17% losses may occur during postharvest operations and storage (Shah *et al.*, 2002). The

drying can be the best option to avoid losses and to increase the shelf life of apples (Famurewa *et al.,* 2006). Sun drying is a common method among growers followed to produce sun dried apple rings commonly known as *Sakori* but the quality of sun dried apples is very poor. Dried fruits are beneficial to human health because they are rich sources of vitamins, minerals, antioxidants and especially fibres (including soluble fibres) due to their concentration during processing (Farzaneh *et al.*, 2011).

Further, the osmotic dehydration (sugar syrup) is a better drying method and is considered as a preservation method that provides high quality product by means of water removal without phase change (Lenart, 1996). However, keeping in view the health concern of the consumers, honey can be used as replacer of sugar in hypertonic solution which can give a better osmo-dried product with good nutritional value.

The apple rings prepared with traditional technology are not fetching better price due to their appearance and taste. Therefore, the novel products development from dried apple by using them in bakery and confectionary can be a profitable venture. In confectionary, chocolate are favorite among children as well as young generation and is a highly nutritious energy source, with a fast metabolism and good digestibility (Pedro *et al.,* 2006). Chocolate can be utilized for the development of novel and children friendly apple products like apple chocho shots by filling with dried apples and apple pie by filling stewed apples can be another novel product.

Thus, keeping in view the demand of innovative products in the market and huge scope of using apple fruits, the present study was conducted to develop consumer's friendly novel products from apple and osmo dried apples.

Materials and Methods

Raw materials

The apple fruits (*Golden delicious*) harvested at optimum maturity was procured from the local market. Raw material was purchased from the local market and multifloral honey was procured from the local farm, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, H.P used for conducting this study.

Methods and procedure

The dipping time for apple pops and apple rings was optimized initially by selecting firm ripe fruits followed by washing, peeling and preparation of different sizes apple pops and rings. Apple pops (28.08mm diameter) and apple rings (0.5 cm thickness) were prepared and blanched for 30 seconds. The blanched apple pops and apple rings were osmotically dehydrated in hypertonic solution (sugar and honey) at 70^{o}Brix. A known weight fruits were treated with different treatments. The osmosis was carried to optimize the osmotic time at different time interval (1, 2, 3, 4, 5, 6, 7, 8, and 9 h) at 1:3 ratio. The sizes having optimum osmosis were standardized on the basis of drying time. Further from osmo-dried apple pops and apple rings, apple choco shots and apple pie were prepared respectively.

Physico-chemical analysis

Physico-chemical analysis of fresh apple and osmo-dried apple pops, apple rings, apple choco shots, apple pie was conducted by using standard analytical procedures (Ting and Rouseff 1986; AOAC 1996; Ranganna 2009).

Total soluble solids (TSS) content of fresh and processed products was determined by using hand refractometer and sugars were estimated by Lane and Eynon method as detailed by

Ranganna (2009). Acidity was determined by titrating the aliquots against 0.1 N NaOH to a pink end point using phenolphthalein as an indicator (Ranganna 2009). Total phenols were extracted in 80% ethanol and were estimated using Folin-Ciocalteau reagent (AOAC 1996). The antioxidant activity was analyzed by free radical scavenging activity (Brand-Williams *et al.,* 1995). Energy value of the developed products was measured in bomb calorimeter (Model Toshiwal DT-100), which is based on the principle that the amount of heat produced by burning the sample must be equal to the amount of heat absorbed by calorimeter assembly (Kays and Barton, 2002). Further, the non-enzymatic browning (NEB) was determined at 440nm using 60% aqueous alcohol as blank in spectrometer (Spectronic-20).

Water loss (WL) or (Mass transfer) (Sharma *et al.,* 1998)

Water loss was the net loss at time T on an initial mass basis and expressed as in percentage. Water loss in fruits was calculated by using the following formula:

$$\%WL = \frac{IW\text{-}WL\ (T)}{IM} \times 100$$

Where,

IW = Initial water content
WL (T) = Water loss at time T
IM = Initial mass of the sample

Solid gain (SG) or (Mass transfer) (Sharma *et al.,* 1998)

The solid gain was the net sugar transported into the fruits on an initial mass basis and expressed in percentage.

$$\%SG = \%WL - \%MR$$

Where,

WL = Water loss
MR = Mass reduction

The cost of production of apple pops, apple rings, apple choco shots and apple pie was worked out by calculating the cost of raw materials used and after adding processing charges and 20 percent profit.

Statistical analysis

The data on chemical characteristics of fresh and processed products were analyzed statistically by following Completely Randomized Design (CRD) detailed by Cochran and Cox (1992). Triplicate determinations were made for each attributes.

Results and Discussion

Physico-chemical characteristics of fresh apple (*Golden delicious*) and multiforal honey are presented in Table 1. The fresh fruits are found to contain high moisture content (83.90 ± 0.10%) and low titratable acidity of 0.40 ± 0.01 percent with ascorbic acid (8.90 ± 0.10 mg/100g), total phenols (32.50 ± 0.20 mg/100g), flavonoid content (10.00 ± 0.50 %), antioxidant activity (35.50 ± 0.20 %) with non-enzymatic content (0.02 ± 0.02).Crude fibre and total ash were found to be 3.00 ± 0.50 and 2.42 ± 0.02 per cent. Similar results were reported by Sharma *et al.,* (1998), Abdualrahman (2015) and Drogoudi and Pantelidis (2011).

Further, the total soluble solids of fresh honey were 70^{o}B which was more than the values observed by Lakhanpal and Vaidya (2015) and was less than the observations of Kaushik *et al.,* (1993). The free acid, lactose, total acid content in meq per 100g was 3.60, 0.98 and 4.47 respectively which were slightly higher as recorded by Singh and Kaur (1998) and

Kaushik *et.al.* (1993).The fructose and glucose content of honey observed were 35.85 per cent and 30.24 per cent which was in the same range as observed by Singh (1994) and Singh and Kaur (1998). Further, the HMF content observed were 9.35 mg/kg which was lower as reported by Lakhanpal and Vaidya (2015), Bulut and Kilic (2009).

Optimization of dipping time

Different dipping times (1-4 hours) were tried for osmotic dehydration of apple pops and rings in sugar and honey. Table 2 represents the optimization of osmosis dipping time for apple pops in sugar syrup and honey. The percent weight loss, volume gain, increase in TSS of pops and decrease in TSS of syrup was recorded after each hour and found constant after three hours in sugar and after four hours in honey. The dipping of pops in sugar syrup for three hours resulted in 30.6% weight loss with 6.66% gain in syrup volume, 47.6% increase in pops TSS with 14.2% decrease in TSS of syrup. However, four hours dipping of pops in honey resulted in 32.8% weight loss with 5.71% gain in syrup volume, 57.8% increase in pops TSS with 12.7% decrease in TSS of syrup. Henceforth, three hours dip of apple pops in sugar and four hours dip in honey optimized for proper osmosis. Nadia *et al.,* (2013) reported the higher water loss and solids gain at 40^{o}C in pears. Noroes *et al.,* (2010) observed higher water loss and solid gain at the beginning of the osmosis and also reported maximum values at 3.5 hours (65^{o}B sugar syrup) for guava. Whereas, maximum sugar penetration was observed during first 2 hours in apple slices by Morrera and Sereno (2001). Sagar and Kumar (2009) and Nowakunda *et al*., (2004) also reported similar results in mango and banana slices.

Similarly, dipping time for apple rings in sugar and honey syrup is presented in Table 3. The dipping of rings in sugar syrup for three hours resulted in 37.6% weight loss with 8.57% gain in syrup volume, 23% increase in TSS of rings with 17.1% decrease in TSS of syrup. However, four hours dipping of apple rings in honey resulted in 52.7% weight loss with 14% gain in syrup volume, 24.8% increase in rings TSS with 14.2% decrease in TSS of syrup. Henceforth, three hours dipping time for apple rings (sugar) and four hours dipping time for apple rings (honey) optimized for proper osmosis. Further, the drying time of 8 hours for apple pops (sugar), 7 hours for apple pops (honey), 5 hours for apple rings (sugar) and 4 hours for apple rings (honey) has been optimized and standardized. Seiiedlou *et al.,* (2010) also observed that moisture content of samples decreases exponentially with the drying time and increased with increasing the drying air temperature and velocity. Similar results were observed by Figiel (2007) in apple cubes.

Quality characteristics of fresh osmo-dried apple pops and rings (Fig. 1)

On the basis of physico chemical characteristics of honey and sugar dipped apple pops and rings, the osmotic dehydration in honey was found better as compared to sugar (Table 4). The apple pops and rings dipped in honey found to contain 6.72-6.73mg/100g ascorbic acid, 65mg/100g phenols, 68.20-72% flavonoids with 90.10-90.30% antioxidants. The phenol content of apple pops in sugar and honey was found to be 24.00 and 65.00 mg/100g whereas apple rings in sugar and honey contains 24.02 and 65.00 mg/100g phenols respectively.

The water activity of sugar osmo-dried apple pops and rings was high as compare to honey osmo-dried apple pops and rings. On the other hand the non-enzymatic browning of sugar osmo-dried apple pops and rings was found lower as compare to honey osmo-dried apple pops and rings.

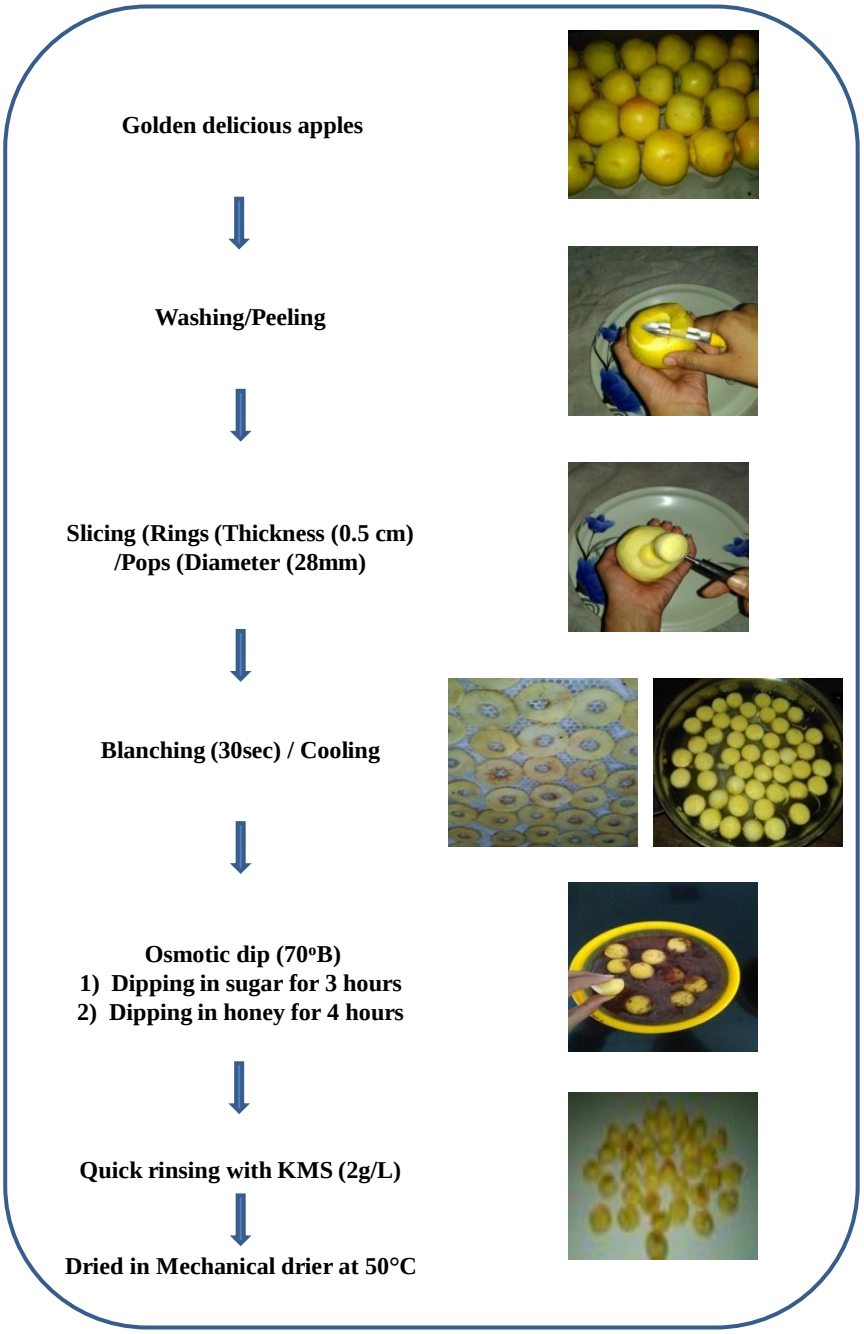

Fig.1 Flow sheet for osmotic dehydration of apple pops and apple rings

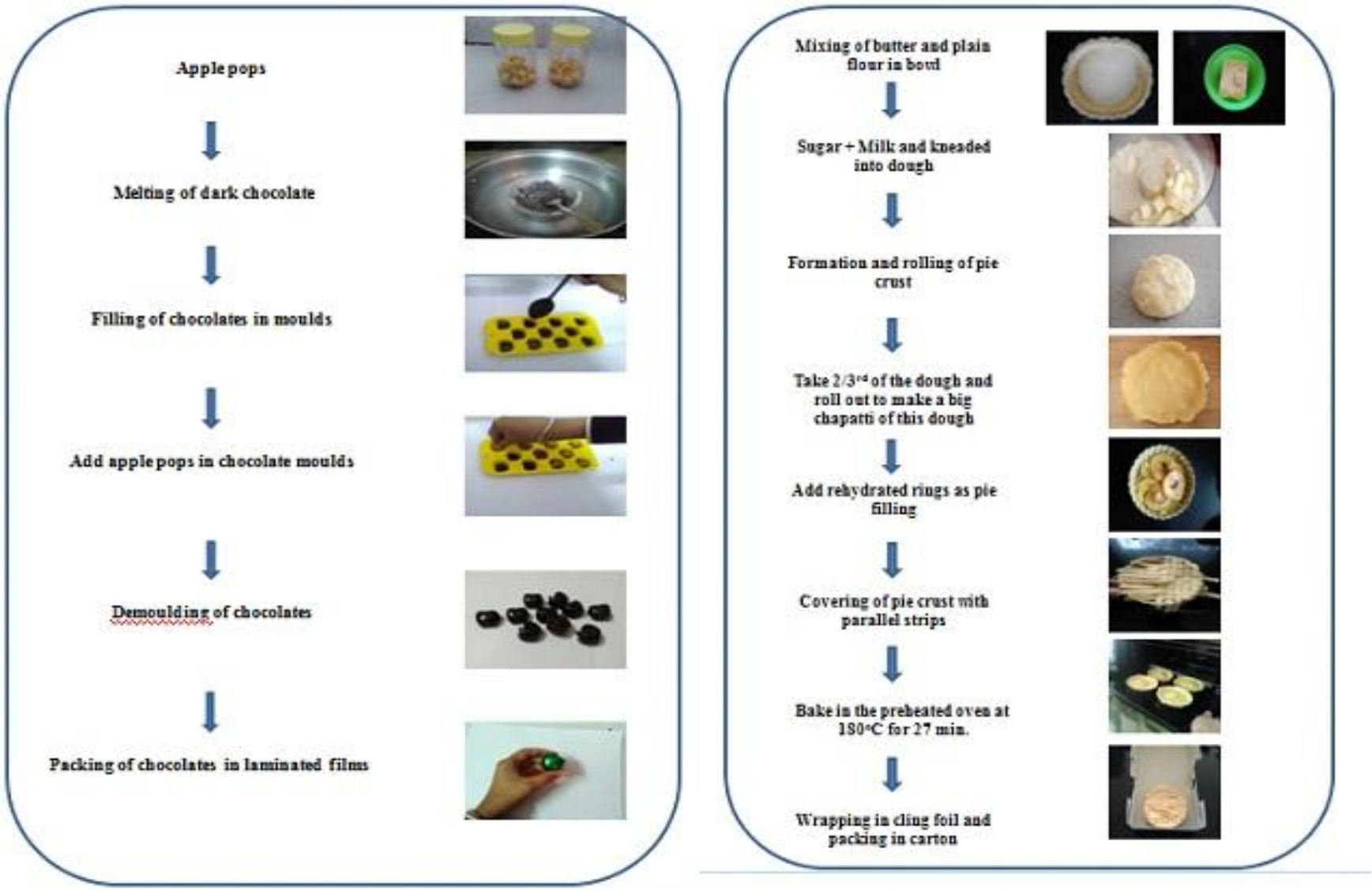

Fig 2: Flow sheet of preparation of apple choco shots and pie

Table.1 Chemical characteristics of apple and multifloral honey

S. No.	Parameter	Fresh apple	Parameter	Honey
1	Moisture content (%)	83.90± 0.10	Total soluble solids (^{o}B)	70.00±1
2.	Ash content (%)	2.42± 0.02	Free acid (meq/100 g)	3.60±0.2
3.	Titratable acidity (%)	0.40± 0.01	Lactone (meq/100 g)	0.98±0.01
4.	Total soluble solids (^{o}B)	15.00± 1.53	Total acid (meq/100g)	4.47±0.01
5.	Reducing sugars (%)	5.00± 0.50	pH	3.86±0.02
6.	Non reducing sugar (%)	3.16± 0.02	Reducing sugars (%)	59.30±0.1
7.	Total sugars (%)	8.33± 0.02	Non-reducing sugars (%)	5.74±0.01
8.	Crude fiber (%)	3.00± 0.50	Total sugars (%)	65.34±0.01
9.	Ascorbic acid(mg/100g)	8.90± 0.10	Moisture (%)	16.5±0.2
10.	Phenols (mg/100g)	32.50± 0.20	Total solids (%)	83.5±0.1
11.	Water activity (a_w)	1.00± 0.50	Ash (%)	0.19±0.01
12.	Flavonoids (%)	10.00± 0.50	Fructose (%)	35.85±0.01
13.	Antioxidants (%)	35.50± 0.20	Glucose (%)	30.24±0.01
14.	Non enzymatic Browning (440nm)	0.02± 0.01	Glucose: Fructose ratio	1.18±0.01
15.			Diastase Number (DN)	20.50±0.1
16.			Total phenols (mg/100g)	65.45±0.02
17.			HMF (mg/kg)	9.35±0.01

Table.2 Optimization of osmo dipping time for apple pops

Parameters / Hours	(%) Weight loss in pops		(%) Volume gain in syrup		(%) Increases in TSS of pops		(%) Decrease in TSS of syrup	
	Sugar 70^{o}B	Honey 70^{o}B	Sugar 70^{o}B	Honey 70^{o}B	Sugar 70^{o}B	Honey 70^{o}B	Sugar 70^{o}B	Honey 70^{o}B
1	23.5	21.1	2.22	1.42	28.5	21.0	8.57	8.57
2	29.8	25.6	4.44	2.85	38.0	31.5	11.4	11.4
3	30.6	27.8	6.66	4.28	47.6	42.1	14.2	14.2
4	30.6	32.8	6.66	5.71	47.6	57.8	14.2	17.1
CD 0.05	0.070	0.070	0.008	0.007	0.263	0.353	0.127	0.178
	NS		NS		0.001		0.001	

Table.3 Optimization of osmo dipping time for apple rings

Parameters / Hours	(%) Weight loss in rings		(%) Volume gain in syrup		(%) Increase in TSS of rings		(%) Decrease in TSS of syrup	
	Sugar 70^{o}B	Honey 70^{o}B	Sugar 70^{o}B	Honey 70^{o}B	Sugar 70^{o}B	Honey 70^{o}B	Sugar 70^{o}B	Honey 70^{o}B
1	35.1	28.0	2.77	4.00	7.69	8.57	11.4	10.0
2	36.3	37.5	5.71	8.00	15.3	14.2	14.2	11.4
3	37.6	49.2	8.57	12.0	23.0	20.0	17.1	12.8
4	37.6	52.7	8.57	14.0	23.0	24.8	17.1	14.2
CD 0.05	0.081	0.262	0.018	0.348	0.362	0.297	0.176	0.264

Table.4 Quality characteristics of osmo-dried apple pops and rings

Sr. No.	Parameter	Observations					
		Apple pops		CD 0.05	Apple rings		CD 0.05
		Sugar 70°B	Honey 70°B		Sugar 70°B	Honey 70°B	
1	Moisture content (%)	11.50	8.00	1.020	8.60	5.00	1.020
2.	Ash content (%)	1.50	2.00	0.510	1.50	2.00	0.382
3.	Titratable acidity (%)	0.368	0.582	0.003	0.368	0.570	0.024
4.	Total soluble solids (°B)	63.20	65.80	0.126	64.00	65.20	0.499
5.	Reducing sugars (%)	18.60	65.70	0.126	18.64	65.74	0.027
6.	Non reducing sugar (%)	50.57	5.22	0.015	50.58	5.25	0.021
7.	Total sugars (%)	71.83	71.20	0.024	71.88	71.27	0.014
8.	Crude fiber (%)	0.170	0.190	0.013	0.170	0.200	0.025
9.	Ascorbic acid (mg/100g)	5.60	6.72	0.102	5.62	6.73	0.013
10.	Phenols (mg/100g)	24.00	65.00	1.912	24.02	65.00	0.625
11.	Water activity (a_w)	0.617	0.505	0.001	0.620	0.510	0.025
12.	Flavonoids (%)	62.40	68.20	0.080	66.00	72.00	0.637
13.	Antioxidants (%)	79.09	90.30	0.225	75.98	90.10	0.160
14.	Non enzymatic Browning(440nm)	0.041	0.126	0.001	0.050	0.114	0.014

Table.5 Quality characteristics of apple choco shots and apple pie

S. No	Parameters	Observations					
		Apple choco shots		$CD_{0.05}$	Apple pie		$CD_{0.05}$
		Sugar 70°B	Honey 70°B		Sugar 70°B	Honey 70°B	
1.	**Water activity (a_w)**	0.587	0.487	0.001	0.827	0.787	0.001
2.	**Energy (Kcal/100g**	418.08	430.09	0.458	255.86	260.74	0.240
3.	**Protein (%)**	5.84	5.88	0.014	9.30	9.32	NS
4.	**Crude fibre (%)**	0.73	0.72	0.006	1.48	1.48	0.013
5.	**Fat content (%)**	31.00	31.00	NS	14.00	14.05	NS
6.	**Ash content (%)**	1.65	2.15	0.013	1.20	1.23	NS
7.	**Carbohydrates (%)**	60.78	60.25	0.058	74.02	73.84	NS

Table.6 Cost of production of apple pops and apple rings

Ingradients	Rate (Rs.)	Apple pops (2g)				Apple rings (4g)			
		Sugar		Honey		Sugar		Honey	
		Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
Apple	20/kg	100kg	2000	100kg	2000	100kg	2000	100kg	2000
Sugar	40/kg	84 kg	3360	-	-	84 kg	3360	-	-
Honey	200/L	-	-	120 L	24000	-	-	120 L	24000
Total			5360		26000		5360		26000
Processing charges (15%)			804		3900		804		3900
Total cost			6124		29900		6124		29900
Recovery of syrup* (cost reduced@70% of sugar/ honey cost)			2352		16800		2352		16800
Cost of production			3772		13100		3772		13100
Profit (20%)			754.40		2620		1224.80		5980
Total cost of production			4526.40		15720		4526.40		15720
Yield, (No's pops/rings)			6000		6000		8000		8000
Cost of 1 pop/ring			**Re 0.75**		**Rs2.62**		**Re 0.57**		**Rs1.96**

*syrup recovered has been utilized for further product developments (drinks etc)

Table.7 Cost of production of apple choco shots and apple pie

Ingredients	Rate (Rs.)	Apple choco shots (13g)				Apple pie (100g)			
		Sugar		Honey		Sugar		Honey	
		Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
Apple pop (Sugar)	0.75/p	6000	4500	-	-	-	-	-	-
Apple pop (Honey)	2.62/p	-	-	6000	15720	-	-	-	-
Chocolate	200/Kg	60 Kg	12000	60 Kg	12000	-	-	-	-
LamiNSted films	Re 0.50/pc	6000	3000	6000	3000	-	-	-	-
Apple ring (Sugar)	0.57/p	-	-	-	-	8000	4560	-	-
Apple ring (Honey)	1.96/p	-	-	-	-	-	-	8000	15680
Maida	30/Kg	-	-	-	-	40 Kg	1200	40 Kg	1200
Butter	250/Kg	-	-	-	-	15 Kg	3750	15 Kg	3750
Milk	45/ltr	-	-	-	-	5 ltrs	225	5 ltrs	225
Sugar	40/kg	-	-	-	-	5 Kg	200	5 Kg	200
Packing	3/pieces	-	-	-	-	1000	3000	1000	3000
Total			19500		30720		12935		24055
Processing charges (15%)			2925		4608		1940		3608
Cost of Production			22425		35328		14875		27663
Profit (20%)			4485		7066		2975		5533
Total Cost of Production			26910		42394		17850		33196
Yield (No's chocho shots/pie)		6000		6000		1000		1000	
Cost of 1 shot/pie		**Rs. 4.49**		**Rs. 7.06**		**Rs. 17.85**		**Rs. 33.20**	

Quality characteristic of apple choco shot and pie (Fig. 2)

Apple choco shots were prepared from osmo-dried apple pops and apple pie from osmo-dried apple rings. The quality characteristics of apple choco shots and pie are presented in Table 5 shows an improved energy value of apple choco shots and pie dipped in honey syrup with energy value of 430.09 and 260.74 Kcal/100g as compared to 418.08 and 255.86 Kcal/100g in sugar dipped apple choco shots and pie respectively. The protein content of 5.84 and 5.88 percent was observed in apple choco shots and 9.30 and 9.32 percentin apple pie with sugar and honey respectively. Whereas, almost similar fat contents were observed in apple choco shots and pie with sugar and honey. The water activity of apple choco shots and pie (Sugar) and (Honey) was found 0.587, 0.827 and 0.487, 0.787 0.827 and 0.787a_W respectively. These results are in agreement with Ayub *et al.*, (2003).

Cost of production

The cost of production of apple pops (Sugar and honey) and apple rings (Sugar and honey) detailed in Table 6, apple choco shots (Sugar and honey) and apple pie (Sugar and honey) in Table 7 was calculated on the basis of current market prices of ingredients, nominal processing charges @15% and reasonable profit margins @20%. The cost of apple pops (Sugar and honey) was calculated to be Re 0.75 and Rs 2.62 and for apple rings (Sugar and honey) as Re 0.57 and Rs 1.96 respectively. Further, the apple choco shots prepared from apple pops and apple pie from apple rings costs Rs 4.49 and Rs 17.85 with sugar and Rs 7.06 and Rs 33.20 with honey, respectively.

On the basis of results presented, it can be concluded that the apple fruits can be utilized for the preparation of osmo-dried apple pops and apple rings. These osmo-dried products can further be utilized for the development of apple choco shots and apple pie which are the new products in the market. Further, the use of honey for osmotic dehydration improves the nutritional quality of the developed products. Henceforth, the developed technology will be boon to apple processing industry and can be commercially explored at industry level for the production of quality value added products like osmo-dried apple pops and apple rings with apple choco shots and apple pie as novel products.

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