



Drying characteristics of wild apricot (*Prunus armeniaca*) fruit bar and economic evaluation of market potential of the enterprise

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ABSTRACT

An experiment was conducted to study the drying characteristics of wild apricot (*Prunus armeniaca* L.) fruit bar and evaluation of the economic feasibility of the enterprise. Wild apricot fruits were harvested at optimum maturity from Dist Tehri-Garhwal, Uttarakhand and after thorough sorting and proper washing, used for hot extraction of pulp through a pulper. Pulp was preserved in 500 ppm SO₂. Wild apricot fruit bar was prepared by pre-standardized recipe using wild apricot pulp + 60 % sugar + 0.30 % pectin and drying the mixture in a mechanical dehydrator at 55 ± 2°C for 6 hours. Dried fruit bar sheets were cut into rectangular shapes (1.0×1.5 in²) using a stainless steel knife and wrapped in polythene paper. Results on the drying rate indicate that for preparation of fruit bar we can dry the mixture of pulp, sugar and pectin within six hours in a mechanical dehydrator after boiling for 20 min over the flame. It was also observed that most of the moisture loss occurs during the process of heating / boiling over the flame and the product stabilizes and sets into a bar during mechanical dehydration with only small percentage of moisture loss. The mass balance thus indicates that about 9.11 kg of wild apricot fruit bar is obtained from 10 kg of pulp. The economic indicators such as B/C (3.55), PBP (1.68 years), IRR (55.4%) revealed the sound financial position of wild apricot fruit bar production unit and hence existing (fruit processing unit) as well as potential entrepreneurs in various hill states of India including Uttarakhand, Himachal Pradesh, Jammu and Kashmir etc. can enter into this venture.

Key words: Apricot, Benefit Cost Ratio, Drying characteristics, Fruit bar, *Prunus armeniaca*, Pay Back Period, Internal Rate of Return

Apricot (*Prunus armeniaca* L.) is considered as one of the most delicious temperate fruits of the world and is also grown in many hilly states of India including Jammu and Kashmir, Himachal Pradesh and Uttarakhand (Bhat *et al.* 2002, Sharma *et al.* 2011). The total apricot production in the world about 3 831 823 tonnes from an area of 520 455 ha (FAO 2010). Out of this, India produces about 10 000 tonnes of cultivated apricot from an area of 2 400 ha. On an average the productivity is about 4.17 tonnes/ha. In Uttarakhand, apricot (including wild forms) is grown over an area of 9 156 ha producing about 30 948 tonnes of fruits annually (Anon 2008). The fruits are a rich source of carbohydrates and minerals besides having attractive colour and typical flavour (Ghorpade *et al.* 1995). Sugars like glucose, fructose, sucrose, sorbitol and malic acid and citric

acid are the principal constituents present in it, besides being a good source of minerals such as potassium, sodium and iron but deficient in protein and fat (Lal *et al.* 1989, Hui 1992). The fruits of wild apricot are high in acidity, low in sugar content and poor in sensory acceptability in comparison to the table purpose varieties of apricot, i.e. Charmagz, Shakarpara and New Castle, which makes them unsuitable for fresh consumption. Hence, wild apricot fruits are almost wasted in India.

The authors in their previous study standardized the process protocol for the preparation of wild apricot fruit bar with good sensory acceptability (Sharma *et al.* 2011). The drying characteristics of a product like fruit bar are very important for fixing the process variables and economic feasibility of a technology for its adoption as commercial venture, both of which are lacking in literature specifically for wild apricot fruits bar. Therefore, in the present study, drying characteristics of the product were studied alongwith evaluation of the economic feasibility of the enterprise so as to understand the potential of the technology for setting up a cottage/small scale processing industry. Generation of the said information would boost the commercial adoption of

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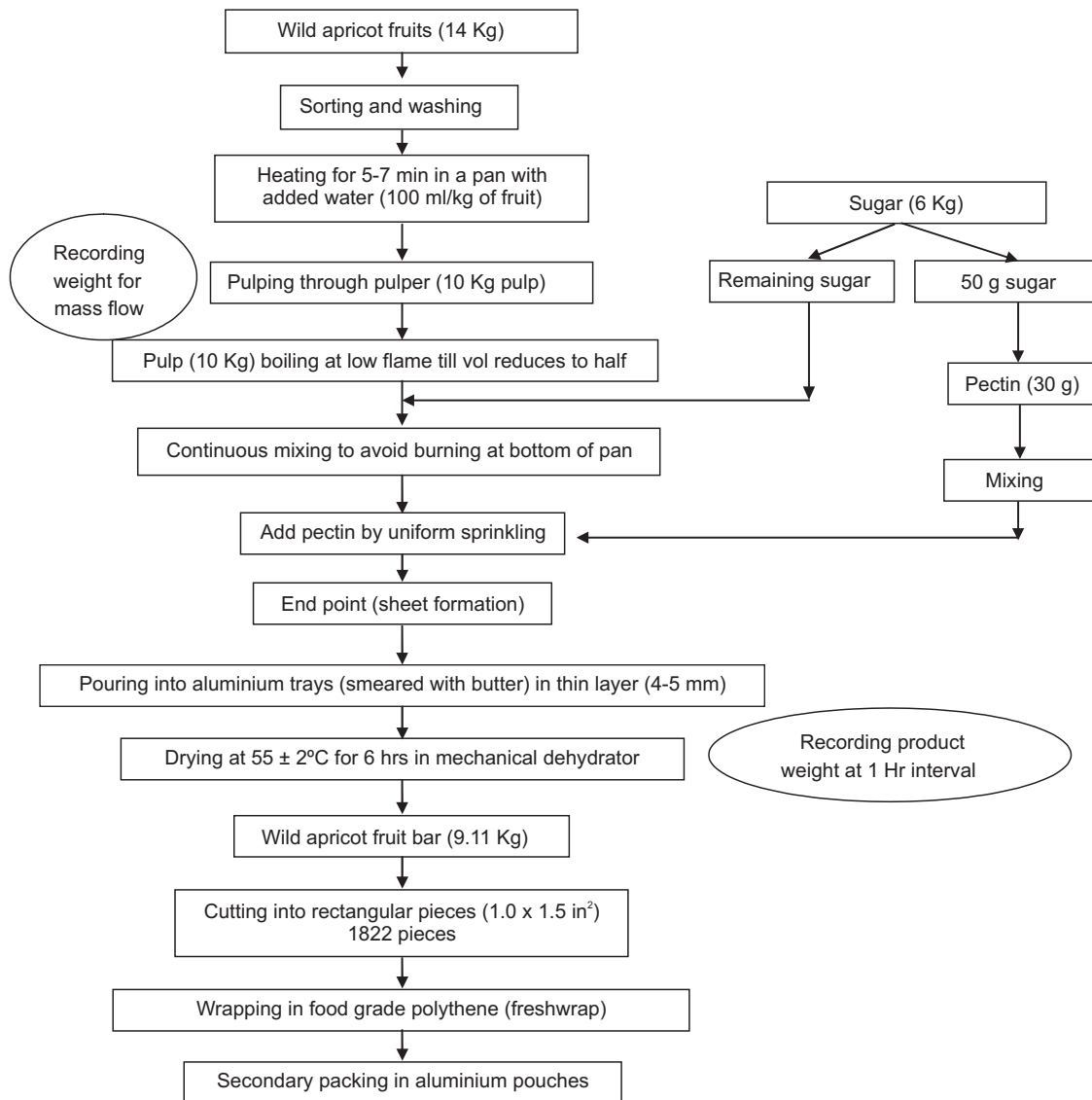


Fig 1 Protocol for preparation of wild apricot fruit bar

the technology and increase the popularity of the product as that to mango fruit bar which is very popular in India.

MATERIALS AND METHODS

Wild apricot fruits were procured from the orchard of Department of Horticulture, G B Pant University of Agriculture and Technology, Hill Campus, Ranichauri, Distt Tehri-Garhwal, Uttarakhand, India and nearby local areas, located between of 1500 - 2000 m amsl. Fruits were analysed for physico-chemical quality before being used in further experiments using standard procedures. After thorough sorting and proper washing, fruits were heated for 5 to 7 min in a stainless steel pan by adding water (100 ml/kg of fruit) and passed through the pulper for extraction of pulp. Wild apricot pulp was collected and stored in pre-sterilized plastic barrels with added SO_2 @ 500 ppm. Fruit bar was prepared by pre-

standardized recipe using wild apricot pulp + 60 % sugar + 0.30% pectin and drying the mixture in a mechanical dehydrator at $55 \pm 2^\circ\text{C}$ for 6 hours (Sharma *et al.* 2011).

Wild apricot pulp (1.5 kg in one lot) was boiled over a low flame till its volume reduced to half, and then weighed quantity of sugar was added. About 50 g of sugar was retained for mixing in pectin for its uniform distribution. Weighed quantities of pectin were added to the mixture of pulp and sugar by uniform sprinkling and continuous mixing. The mixture when ready was poured into aluminium trays (smeared with butter) in layers of about 4 - 5 mm thickness. The trays were kept in mechanical dehydrator and product was dried at $55 \pm 2^\circ\text{C}$ for about 6 hours. After drying, fruit bar sheets were cut into rectangular shapes ($1.0 \times 1.5 \text{ in}^2$) using a stainless steel knife (Sharma *et al.* 2011).

Standard procedures were followed for the estimation of

physico-chemical quality parameters like moisture, acidity, reducing sugars, total sugars, ascorbic acid and sensory quality (Ranganna 1997, Sharma and Nautiyal 2009). Sugars were determined by Nelson-Somogyi method and ascorbic acid by direct colorimetric method using 2,6 dichlorophenol indophenols dye. Drying rate was studied by recording the weight of the product at 1 hour interval during drying in mechanical dehydrator. The weight loss occurring during the product heating, i.e boiling over the flame was also plotted against time. Final product obtained was also weighed to work out the mass balance. The economics analysis was carried out for scale up unit considering fixed cost (machinery and equipments) and variable cost including raw materials, labour, packaging etc.

RESULTS AND DISCUSSION

The fruits of wild apricot used in present investigation having weight, volume, length and diameter ranging from 8.50 to 19.00 g, 8.00 to 18.00 ml, 26.0 to 34.4 mm and 22.3 to 30.9 mm, respectively (Table 1) were of very small size and can be placed in Grade 2 (<36 mm dia.) as per the size grades of apricot given by Sharma (2010). The smaller size of apricot fruits used in the present study is common everywhere because trees of wild apricots are seldom pruned, therefore bearing heavy crop load but of poor fruit size and quality. In earlier studies, the fruit length in various cultivars of apricot is reported to vary from 2.64 to 4.70 cm (Sud *et al.* 1979, Bhatia *et al.* 1997, Sharma *et al.* 2004). Similarly, the fruit diameter varies from 2.35 to 4.82 cm in various apricot cultivars (Bhatia *et al.* 1997, Sharma and Sharma 1990, Prakash 1999). Our observations for the size parameters of different apricot cultivars are well in corroboration with the earlier findings. Similarly, the fruit firmness of 0.76 to 1.86 kg/cm² recorded in our study is also in conformity with the

Table 1 Physico-chemical characteristics of wild apricot fruit

Characteristics	Range	Mean ± SE
Length (cm)	2.60 – 3.44	2.95 ± 0.04
Diameter (cm)	2.23 – 3.09	2.64 ± 0.04
Fruit weight (g)	8.50 – 19.00	12.58 ± 0.55
Fruit volume (ml)	8.00 – 18.00	12.70 ± 0.55
Pulp (%)	88.35 – 92.63	89.76 ± 0.23
Seed weight (g)	0.90 – 1.40	1.27 ± 0.03
Seed (%)	7.37 – 11.65	10.24 ± 0.23
Total solids (%)	15.44 – 16.02	15.60 ± 0.12
Firmness (Kg/cm ²)	0.76 – 1.86	1.19 ± 0.07
Moisture (%)	83.98 – 84.56	84.40 ± 0.12
TSS (°Brix)	13.00 – 13.20	13.10 ± 0.02
Titrate acidity (%)	2.75 – 2.85	2.80 ± 0.009
Total sugar (%)	7.51 – 7.58	7.54 ± 0.007
Reducing sugar (%)	7.25 – 7.33	7.31 ± 0.008
Ascorbic acid (mg/100g)	7.35 – 8.82	8.33 ± 0.15
Ash (%)	0.62 – 0.69	0.65 ± 0.01

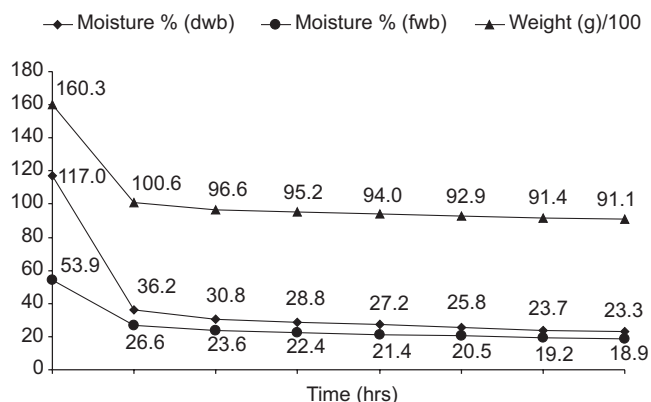


Fig 2 Drying rate curves of wild apricot fruit bar

earlier findings of Shah (1986) and Sharma *et al.* (2004). As far as the physico-chemical quality parameters are concerned, the moisture content and TSS value are well within the range of 82.40 to 86.78% and 7.80 to 18.32 °Brix, respectively (Srivastava *et al.* 1970 and Sharma *et al.* 2004). Further, the high acid contents, as recorded in present study (2.75 - 2.85 %) are characteristic feature of wild apricot fruits. The results of our study for various physico-chemical characteristics of wild apricot fruits are in close agreement with those reported earlier for different cultivars of apricots.

Data in Fig 2 depict the drying rate curve of wild apricot fruit bar prepared by using the standardized recipe consisting of pulp + sugar (60%) + pectin (0.30%). As evident that the major proportion (about 86.27%) of total water lost was removed during boiling stage of the pulp over flame before addition of sugar and pectin with corresponding reduction of moisture from 117 to 36.2% on dry weight basis. But after addition of pectin it was not possible to remove much moisture by heating over the flame as setting of the fruit bar mixture began as soon as pectin was added. If product had further been heated over the flame, the setting of the gel would have been disturbed and burning might have also taken place at the bottom of the pan in which product was being cooked. Therefore, it became necessary to shift the product to trays for further drying in a dehydrator. There was a continuous decline in the product weight up to 6 hours when dried in mechanical dehydrator at temperature of 55 ± 2°C. It can be clearly observed that there was a sharp decrease in fruit weight during initial 1 hour of drying from 10.06 to 9.66 kg wherein approximately 5.4 and 3.0% moisture loss were observed on dry and fresh weight basis respectively. Gradual loss in moisture was observed after 1 hour till 5 hours. During the last hour of drying, weight almost stabilized and a weight loss of just 0.3 % was recorded. Literature also indicates that during falling rate period the rate of moisture removal is reduced (Sharma *et al.* 2005). The moisture content of the final product was 18.9 and 23.3% on fresh and dry basis respectively, which indicates that this product is an intermediate moisture food and do not require any refrigeration during storage. Sharma (2010) also reported

that the foods containing 20-50% moisture are intermediate moisture foods and do not require any refrigeration during storage and can be eaten without rehydration. The authors in their previous study have already shown that the wild apricot fruit bar is shelf stable for a period of 6 months even at ambient conditions (Sharma *et al.* 2011).

The mass balance indicates that from 10 kg of wild apricot pulp after addition of 6 kg sugar and 30 g pectin about 9.11 kg of fruit bar is obtained (Fig 3). Maximum moisture, i.e. 5.97 kg is lost during initial heating of the pulp over the flame while only 0.95 kg of moisture is lost during drying in a mechanical dehydrator. Mass Balance also indicates that wild apricot fruit bar representing 91.1% yield on pulp basis while on total fruit basis the yield comes to approximately 65%.

The benefit cost analysis done on the basis of the mass

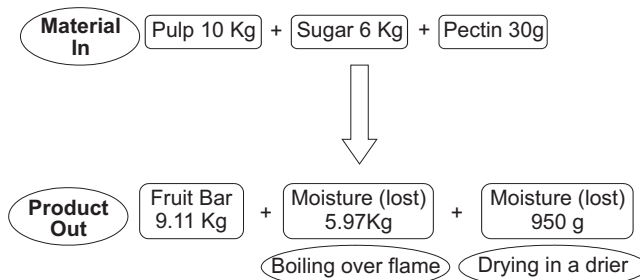


Fig 3 Mass balance of process of preparation of wild apricot fruit bar

balance given in Fig 3, for production of wild apricot bar (up scaled unit) reveals that an entrepreneur can earn profit to the tune of ₹ 5.61 lakh per season (Table 2) from this enterprise. All economic feasibility indicators such as benefit cost ratio

Table 2 Economic analysis of production of wild apricot fruit bar

Cost/ benefits		Amount (₹)	
A	Total fixed cost, machinery (fruit washing machine, pulper, tray drier, shrink wrapping machine and weighing balance) including installation charges (₹)		383 000
	i. Depreciation on main machinery @ 10% per annum after deduction of salvage value (₹)		34 470
	ii. Interest on fixed capital@ 10% per annum (₹)		38 300
	Annual fixed cost [Sub- total (i+ii)]		72 770
B.	Variable cost		
	iii. Cost of raw material (Wild apricot)	<i>Qty (q/kg)</i>	<i>Price (₹/kg)</i>
		60 q	4
	iv. Sugar	25.7 q	32
	v. Pectin	12.9 kg	300
	vi. Butter	64 kg	200
	vii. Repair and maintenance (₹/year)		2 000
	viii. Fuel and electricity charges (₹)	<i>Units</i>	<i>Charge (₹/unit)</i>
		2 500	4.5
	ix. Labour charges for various operations	<i>Man days</i>	<i>Rate/cost (₹/unit)</i>
		1800	150 per day
	x. Packaging material (₹)		5 000
	xi. Other miscellaneous expenses (₹)		5 000
	Sub-total B (iii to xi)		146 990
C	Total cost (i+ii+B)		219 680
D.	Returns		
	xii. Recovery of pulp	<i>Qty (q)</i>	<i>Rate (₹/unit)</i>
		42.9	
	xiii. Fruits bar obtained	39	
	xiv. No of fruits bar packets@ 50 g/pkt		
	One packet contains 10 bars (each bar size of 1.0 × 1.5 in ²)	78091	10/pkt
	Total returns D (₹)		780 910
E	Net profit (D-C), ₹		561 230
F	Cost of production (₹/pkt of 50g)		2.81
G	Benefit cost ratio (B/C)	3.55	
H	Payback period (PBP) (including one year gestation period for installation)	1.68 years	
I	Internal rate of return (IRR)	55.4%	

(3.55), Pay Back Period (1.68 years) and Internal Rate of Return (55.4%) were found good which indicate that this venture is financially sound. It would be worth to mention that the plant will run for only three months in a year and the availability of wild apricot fruits is for 20 days only. Interestingly, the Pay Back Period is very less, i.e. < 7 months if installation period of one year is excluded. Considering 3 months economical operation of the unit, at least two seasons will be required to repay the capital amount. Sale of the product (Wild apricot bar) may be introduced on the similar pattern of mango fruit bar. However, the prepared bar need to be properly packed in attractive package otherwise may adhere to stiff competition from other fruit bar in the market.

Conclusively, it emerges that the wild apricot fruit bar can successfully be prepared by using wild apricot pulp + 60 % sugar + 0.30 % pectin and drying the mixture in a mechanical dehydrator at $55 \pm 2^\circ\text{C}$ for 6 hours. Maximum weight loss occurs during boiling stage and the product is stabilized very well during drying in mechanical dehydrator. Final moisture of the product is 18.9 and 23.3 % on fresh and dry basis respectively and the product can be considered in the category of intermediate moisture food. From 10 kg of fruit pulp, 9.1 kg of fruit bar can be obtained. The economic analysis of the product indicates high profitability of this venture. The economic indicators such as B/C (3.55), PBP (1.68 years), IRR (55.4%) revealed the sound financial position of wild apricot fruit bar production unit and hence existing (fruit processing unit) as well as potential entrepreneur in the country can enter into this venture

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