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Research Article

The Effect of Different Processing Techniques in Production of Mulberry and Apricot Molasses (Pekmez)

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Abstract

In this study, molasses was produced from mulberry and apricot by use of processing techniques of battery, press, decanter-separator and horizontal press at the pilot plant level. Water-soluble dry matter (brix) and turbidity values were determined in the pomace of mulberry and apricot extracts obtained in the trials performed with each of the fruits. Hydroxymethylfurfural (HMF), ash, sediment and microbiological analyzes were carried out on mulberry and apricot molasses obtained from these extracts. In addition, raw material input rate, product output rate, process time, level of energy consumed and cost were calculated. Establishment of firstly the compliance of the molasses with the codex and then the cost lowness was taken into consideration when determining the optimum values.It was seen that the increase in temperature, amount of fruits and time resulted in increase in product output rate in battery processing technique, and that these increases were higher in mulberry when compared to apricot. When the product output rates of mulberry and apricot for battery processing technique were reviewed, it was seen that product output rate increased by the increase in temperatures, enzyme dose, fruit ratio and time, and this increase was much higher in mulberry. When the yield of decanter separator processing technique for both fruits were reviewed, it was found out that the yield parameters were associated with the feed rate of decanter separator rather than the water temperature, the enzyme dose and the fruit:water ratio used in extraction, and that the energy consumed increased as the raw material input rate increased and the process time decreased as the decanter feed rate increased. When the product output rates of mulberry and apricot for horizontal extraction processing technique were reviewed, it was seen that the horizontal extraction technique gave close values for both fruits, and that the extraction temperature and amount of fruit increased gradually.It was found out that the optimum conditions vary in the molasses production techniques used in this study, and the best method for production of mulberry and apricot molasses is the decanter separator processing technique. The optimization conditions for the production of mulberry and apricot molasses were established and it was tried to contribute to the molasses industry by the values obtained.

Keywords: Apricot, Molasses(Pekmez), Mulberry, Process, Techniq

Dut ve Kayısı Pekmezi Üretiminde Farklı İşleme Tekniklerinin Verimlilik Optimizasyonu

Öz

Bu araştırmada, dut ve kayısı meyvelerinden pilot tesis düzeyinde batarya, pres, dekantör- seperatör ve yatay pres işleme teknikleri kullanılarak pekmez üretimi yapılmıştır. Her meyve ile yapılan denemede elde edilen dut ve kayısı ekstraktının posasında, suda çözünür kuru madde (biriks) ve bulanıklık değeri ölçülmüştür. Bu şıradan elde edilen dut ve kayısı pekmezinde ise hidroksimetilfurfural (HMF), kül, tortu ve mikrobiyolojik analizleri yapılmıştır. Ayrıca hammadde girdi hızı, ürün çıktı hızı, proses süresi, harcanan enerji düzeyi ve maliyet hesaplanmıştır. Optimum değerler belirlenirken öncelikle pekmezin kodekse uygunluğu ile düşük maliyet durumunun saptanması göz önünde bulundurulmuştur. Batarya işleme tekniğinde dut ve kayısı pekmezinde artan sıcaklık, meyve miktarı ve sürenin ürün çıktı hızını artırdığı, dut meyvesindeki artışların kayısı meyvesinden daha yüksek olduğu belirlenmiştir. Pres işleme tekniğine göre dut ve kayısı meyvelerinin ürün çıktı hızları incelendiğinde, artan sıcaklık dereceleri, enzim dozu, meyve oranı ve sürenin ürün çıktı

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hızını artırdığını bu artışın dut meyvesinde daha yüksek değerlere ulaştığı görülmüştür. Her iki meyve için dekantör seperatör işleme tekniği verimleri incelendiğinde verim parametrelerinin ekstraksiyonda kullanılan suyun sıcaklık derecesi, enzim dozu ve meyve:su oranından çok dekantör separatör besleme hızıyla ilişkili olduğu, dekantör besleme hızı artırılınca hammadde girdi hızı ile harcanan enerjinin artış gösterdiği ve proses süresinin kısaldığı belirlenmiştir. Yatay ekstraksiyon işleme tekniğinde dut ve kayısı meyvelerinin ürün çıktı hızları incelendiğinde ise yatay ekstraksiyon tekniğinin diğer tekniklere göre her iki meyve için birbirine yakın değerler verdiğini, ekstraksiyon ısı derecesi ve meyve miktarının giderek arttığı görülmüştür. Yapılan bu çalışmada kullanılan pekmez üretim tekniklerinde, optimum koşulların değişkenlik gösterdiği, dut ve kayısı pekmezi üretimi için en uygun yöntemin dekantör seperatör işleme tekniği olduğu belirlenmiştir. Dut ve kayısı pekmezi üretiminde optimizasyon koşulları saptanmış ve elde edilen değerlerle pekmez endüstrisine katkı sağlanmaya çalışılmıştır.

Anahtar Kelimeler: Pekmez, Dut, İşleme, Kayısı, Teknik

1. Introduction

Being one of our traditional foods and fruit utilization methods specific to our country, molasses(pekmez) is produced both industrially and by local production techniques in rural areas. The relevant TSE (Turkish Standard Institute) standard defines the molasses as "Grape, mulberry and fig molasses is a food product with thick viscosity obtained by decreasing the acidity with calcium carbonate or sodium carbonate without reducing the acidity of fresh or dried grape, mulberry, carob and fig extract, and then clarifying with tannins, gelatin and suitable enzymes, thickening under vacuum or in open top tank in accordance with the current technique, and finally mixing with addition of honey, chalk plant, milk, milk powder and egg white." (Anonymous, 1989; Anonymous, 1996; Anonymous, 1997; Anonymous, 2016).

Molasses is obtained from sugar products such as fresh or dried mulberry, fig, plum, apple, carob, wild pear, pear, cranberry, watermelon, Syrian juniper (*juniperus drupacea*), date, plum, apricot, sugar cane, sorghum, sugar beet and blackberry. The molasses content varies depending on the species, type, production conditions and processing techniques of the fruit it is produced (Figure 1). Although it varies depending on the fruit composition, the composition of molasses varieties mainly consists of carbohydrates (Kayahan, 1982; Şimsek and Artık, 2002; Koca et al., 2007; Alasalvar et al., 2005; Uçar, 2008). The basic carbohydrates contained in molasses, which is a good carbohydrate and energy source due the natural presence of sugar in its composition, are generally glucose and fructose, which constitute the main energy source. In addition, molasses has a high mineral substance content, and meets most of the calcium, iron, potassium and magnesium needs in particular (Simsek and Artık, 2002; Kolaylı et al., 2003; Şimşek et al.,2004; Koca et al., 2007; Uçar, 2008).

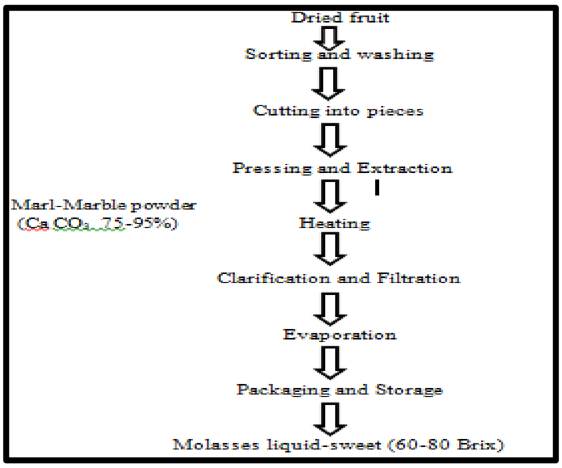

Figure 1. *Stages of molasses(pekmez) production*

In a study carried out to determine the compositions of grape, mulberry, fig and carob molasses produced widely in our country, the total dry matter (79%), water soluble dry matter (brix) (75%) fructose (34.42%), glucose (34.99%), total ash (3.83%), K, (978 mg/100g), P (87 mg/100g), Hunter L (19.33) and Hunter b (0.64) in grape molasses; total sugar (68.79%), formol number (11), sucrose (44.38%), alkali number (14.12) and Hunter a (0.68) in carob molasses, titration acidity (1.008%), HMF (33.6 mg / kg), ash alkalinity (27.32), Ca (562 mg/100g), Mg (94 mg/100g), Na (88 mg/100g), Fe (1.86 mg/100g), Mn (1.20 mg/100g), Zn (0.63 mg/100g) in fig molasses, and Cu (0.49 mg / 100g) and pH (5.56) in mulberry molasses were reported to be the highest values (Şimşek and Artık, 2002). In a study performed on Syrian juniper *(J. Drupacea)* molasses, molasses was found to be rich in some nutritional components such as sugar (34.97 g/100 g), ash (3.79 g/100 g), Ca, (1499 mg/kg), P (1445 mg/kg) and Zn (12.79 mg/kg) (Akıncı et al., 2004). Total sugar, protein, oil, ash, pectin, tannin and cellulose contents were found to range between 32.99-79.39%, 2-6.4%, 0.1-0.7%, 1.6-3.9%, 1.3-14.3%, 0.4-2.5% and 2.5-12.3% in the ripening period of 5 different commercial dates. The date is also a fruit with the highest K (402.8-1668.6 mg/100g) and lowest Na (1.5-9.4 mg/100g) contents (Al-Hooti et al., 1997).

Even though molasses has been produced for long years in Turkey, the production techniques have not changed greatly until 10-15 years ago, and the required technology has not been accessed sufficiently throughout the country yet. Molasses production under vacuum is required to be improved and made widespread in order to ensure safe and high-quality molasses production (Kayahan, 1982; Velioğlu and Artık, 1993). This is to avoid increase in the amount of HMF formed by overheating in the boiler.

Molasses is produced under vacuum in modern plants. Today, heat treatment at 67-70 ^{0}C and even lower temperatures under vacuum is possible in many modern plants. Since the heat treatment does not exceed 60-70 ^{0}C in molasses processed by modern method, the HMF (Hydroxymethylfurfural) content is minimized. Since burning and deterioration do not occur in sugar contained in the molasses composition, the molasses produced in this way has much more beneficial effects on health. In addition, there is no burnt taste and odor, and products with higher quality in terms of color are obtained (Kayahan, 1998; Artık et al., 2007; Uçar, 2008).

2. Material and Method

The mulberry and apricot used as raw material in the study were collected in accordance with the sampling requirements at the harvesting stage. The mulberry and apricot brought to Pilot Fruit Juice Processing Plant of Food Engineering Department of Ankara University and SEMAS Gida Sanai were washed and sorted in order to remove or minimize dust, soil, foreign matter, microorganism and pesticide residues on the fruits.

2.1. Mulberry and Apricot

Washed and sorted mulberry and apricot were then processed into molasses using 4 different (battery, press, decanter-separator and horizontal extraction) processing techniques at the pilot plant level of SEMAS Gida Sanai and Ankara University. The conditions of the techniques used are as follows.

2.1.1. Battery Processing Technique

The battery transition time for this process was determined as 20, 25 and 30 minutes, while the water temperature used in extraction was determined as 50, 55 and 60 ^{0}C. Extraction of both fruits was used in such a way that it could weigh up to 170 kg, and maximum 110-160 kg mashed and non-mashed fruits was used for each battery.

2.1.2. Press Processing Technique

The pressing time for the trials on mulberry and apricot was 60, 120 and 180 minutes, and water temperature was 45 and 50 ^{0}C. The amount of mash enzyme used in the water-fruit mixtures prepared was 50 and 75 g/ton, and mash holding time was 60 and 120 minutes, while the fruit-water mixture ratios were 1:9, 2:8 and 3:7.

2.1.3. Decanter Separator Processing Technique

In the trials of Decanter Separator Processing carried out for mulberry and apricot at the pilot plant level, the water temperature was 45 and 50 ^{0}C, and the amount of mash enzyme ranged between 50 and 75 g/ton. Fruit-water mixture ratios of 1:9, 2:8 and 3:7, mash enzyme holding time of 60 and 120 minutes, and decanter feeding rate of 2 and 3 tons/hour were used in the trial. In addition, the decantation time varied depending on the feed rate.

2.1.4. Horizontal Extraction Processing Technique

In the trials of horizontal extraction processing used in the production of mulberry and apricot molasses, the water temperature was 50, 55 and 60 ^{0}C, and amount of fruits was 1250 and 2000 kg, while extraction time was 20, 25 and 30 minutes. The effect of particle size on extraction was determined by trials on mashed and non-mashed fruits.

2.2. Physical and Chemical Analyses

2.2.1. Water Soluble Dry Matter (Brix) Analysis

Water soluble dry matter (Brix) values of fruit pomace and molasses samples were found by digital refractometer (Hanna HI 96800) (Cemeroğlu, 2010).

2.2.2. Ash Determination

After the samples were weighed into crucibles, the crucibles were kept in the oven at 110 ºC overnight, and then they were burnt in an oven at 520 ºC for 5-6 hours until white ash was obtained, and cooled in the desiccator. Then, the amount of ash was calculated by weight loss (Cemeroğlu, 2010).

2.2.3. Turbidimeter Measurement

The pomace and turbidity value of the must obtained in the trial performed with mulberry and apricot was measured by WTW desktop Turb 550 IR (Measuring range: Fruit-water mixture ratios of 1:9, 2:8 and 3:7 were tested ± 0.01 NTU or ± 2% of the measured value).

2.2.4. Amount of Sediment

The sedimentation was determined by taking the mixture, which was prepared by diluting the molasses at a ratio of 1/1, into laboratory tubes of 10 ml and centrifuging it for 15 minutes at 7000 rpm.

2.2.5. Analysis of Browning Level

Approximately 1.5 g of mulberry and apricot and samples of molasses produced therefrom were weighed into centrifuge tubes and brought to volume with 10 mL distilled water. After addition of 20 mL ethyl alcohol, the samples were homogenized by vortex, and then centrifuged (Sigma 2-6, Germany) at 2500 rpm for 5 minutes. After centrifugation, 5 mL of supernatant was taken, and mixed with 5 mL distilled water and 1 mL $K_2S_2O_5$, and then it was re-centrifuged for 5 minutes at 4000 rpm. It was let to rest for 20 minutes, and then the absorbance was measured by UV-VIS (Shimadzu UV mini-1240, Japan) spectrophotometer at 420 nm. The Abs value read was multiplied by the dilution factor, and calculations were made (Cemeroğlu, 2010).

2.2.6. Hydroxymethylfurfural (HMF) Analysis

The hydroxymethylfurfural reacted with p-toluidine and barbituric acid, and the absorbance of the red color formed by this reaction was measured by spectrophotometer at a wavelength of 550 nm. 1-gram mulberry and apricot molasses sample was diluted with distilled water at appropriate ratios, and then it was brought up to volume by addition of 2 mL Carrez I and Carrez II solutions, and mixed by vortex and filtered by Whatman 42 filter paper. 1 mL of filtrate was taken and 2.5 mL p-toluidine solution and 0.5 mL barbituric acid solution was added into it. The absorbance of homogenized samples was read by UV-VIS (Shimadzu UV mini-1240, Japan) spectrophotometer at 550 nm 1-2 minutes and compared to witness sample. The same procedures were applied for the witness sample. However, instead of barbituric acid, the same amount of distilled water was used in the mixture (Anonymous, 1972).

2.3. Microbiological Analysis:

Total mesophilic aerobic microorganisms were cultivated on Plate Count Agar (PCA-Merck 1.05463) by pouring method, and after incubation at 35-37 ^{0}C for 24 hours, colonies formed in this medium were counted (cfu/g). For yeast and mold counts, the colonies (cfu/g) formed after cultivation on Dichloran Rose Bengal Chloramphenicol Agar (DRB-Merck 1.00466) and incubation for 5 days at 22 ± 20 ºC were counted (Özbey et al., 2013).

2.4. Process Analyses

The raw material input rate, product output rate, process time and the level of energy consumed were determined.

2.5. Cost Analysis

The power cost was assumed as TL 0,05 for 1 kg molasses in calculation of unit cost. In addition, the coal spent for 1 kg molasses was calculated as 0.57 kg, and 1 kg coal was calculated over TL 0.47. The average personnel cost was taken as the average monthly cost of shift officers and maintenance/repair officers involved as part of the project. The unit costs were calculated by use of the cost of 1 kg molasses and the amount of molasses produced in the trial.

3. Result and Discussion

Mulberry and apricot were converted into mulberry and apricot molasses by different processing techniques under pilot plant conditions. Within the scope of this study, optimum values were chosen in each production, and firstly, the compliance of the molasses of that fruit with the Turkish Food Codex (TFC), and then the efficiency and cost lowness were taken into consideration. In addition, the value of brix in the fruit pomace is requested to be low in extractions. The turbidity of the must was measured by spectrophotometer at 420 nm transmittance; however, no applicable or repeatable results were obtained. Instead, it was decided to carry out turbidity analysis by turbidimeter.

For microbiological values, the upper limit of mesophilic aerobic microorganism count is 10.000 cfu/g, and 100 cfu/g for yeast-mold. Values higher than abovementioned microbiological values cause the mulberry and apricot molasses to ferment, that is to say to degrade, while the values higher than 8.000 cfu/g and 80 cfu/g also pose a risk. For the processing techniques used in production, the raw material input rate and product output rate are requested to be high, while the process time, the energy consumed and the cost are requested to be low.

3.1. Battery Processing Technique

The product output rates of battery technique for mulberry and apricot molasses are shown in Table 1, the unit costs are shown in Table 2, and the changes in quality parameters are shown in Table 3 and Table 4. Table 1 shows that increased temperature and fruit amount also increased the product output rate, and these increases were higher than apricot in mulberry. It was determined that mashing and non-mashing of the fruits and increased times also act on product output rate.

Table 1. The product output rates in battery trials on mulberry and apricot

Type of Fruit	Temperature (^{0}C)	Product Output Rates (kg/hour)					
		20 min		25 min		30 min	
		Mulberry	Apricot	Mulberry	Apricot	Mulberry	Apricot
Non-mashed, 110 kg	50	188	23	169	21	169	20
	55	211	26	215	24	193	22
	60	211	26	215	24	193	23
Non-mashed, 160 kg	50	246		243		246	-
	55	308		312		281	-
	60	308		312		246	-
Mashed, 110 kg	50	211	63	188	61	169	63
	55	211	71	215	72	193	73
	60	211	76	215	75	193	76
Mashed, 160 kg	50	308	89	273	92	246	91
	55	308	103	312	101	281	110
	60	351	107	312	109	281	110

It was found out that mashing of mulberry and apricot has advantage over the product output rates especially for apricot. As a result, the highest product output rate for mulberry was achieved with a 160 kg mashed fruit capacity at a water temperature of 60 ^{0}C at the end of an extraction time of 20minutes, while optimum product output rate for apricot was achieved with 160 kg mashed fruit at a water temperature of 60 ^{0}C at the end of an extraction time of 30 minutes (Table 1).

The review of the unit costs of battery technique for mulberry and apricot showed that the reduction of battery capacity, which means reduction of amount of fruit to be used in extraction, the use of mashed fruit or fruit that is cut into pieces and increasing the extraction time and the temperature of the water to be used for extraction decrease the unit costs. In discussion of the efficiency of the technique used in extraction, it is requested that the raw material input rate and product output rate are high, and the process time, the energy consumed and cost are low. In fact, it was found out that the unit cost decreased when the product output rate was high in obtaining mulberry and apricot molasses (Table 1 and 2).

Table 2. Unit costs of battery trials on mulberry and apricot

Type of Fruit	Temperature (^{0}C)	Unit costs (TL/kg)					
		20 min		25 min		30 min	
		Mulberry	Apricot	Mulberry	Apricot	Mulberry	Apricot
Non-mashed, 110 kg	50	0.343	0.644	0.310	0.643	0.283	0.631
	55	0.340	0.606	0.304	0.597	0.279	0.594
	60	0.340	0.606	0.304	0.597	0.279	0.581
Non-mashed, 160 kg	50	0.337		0.302	-*	0.273	-
	55	0.333		0.298	-	0.271	-
	60	0.333		0.298	-	0.271	-
Mashed, 110 kg	50	0.340	0.438	0.325	0.404	0.283	0.374
	55	0.340	0.423	0.304	0.387	0.279	0.358
	60	0.340	0.417	0.304	0.382	0.279	0.354
Mashed, 160 kg	50	0.333	0.403	0.300	0.364	0.273	0.337
	55	0.333	0.390	0.298	0.356	0.271	0.322

60	0.331	0.388	0.298	0.352	0.271	0.322

*No data was obtained.

In this trial, production of mulberry molasses by battery technique was tested firstly by 8 batteries for 20 minutes; however, as a result of the preliminary trial, it was seen that the microbial load exceeded the limit values. In addition, when the brix of the pomace was analyzed after each battery, it was observed that there was no change in brix after the 5th battery. Therefore, the trial was performed with 5 batteries for mulberry. Table 3 shows the results of mulberry molasses produced in accordance with the battery system. Mashed mulberry processing results in high must turbidity and sedimentation, and the microbiological values exceed upper limits at 50 ^{0}C and HMF value increases at 60 ^{0}C. On the other hand, when the battery transition time is 30 minutes, the must turbidity exceeds the desired limits (Table 3).

Table 3. Results of battery trials on mulberry molasses

Fruit	Temperature (^{0}C)	Time (min)	Quality Parameters						
			Pomace Brix	Must Turbidity	HMF (mg/kg)	Ash (%)	Sediment	Microorganism (Cfu/g)	
								Mesophile	Mold
Non-mashed, 110kg	50	20	0.9	3+	27	2.88	5+	11380	228
		25	0.9	3+	34	2.79	5+	11450	232
		30	0.8	3+	38	2.80	5+	11390	236
	55	20	0.8	2+	46	2.92	4+	7250	62
		25	0.7	2+	51	2.90	4+	7400	62
		30	0.7	3+	55	2.88	4+	7500	69
	60	20	0.8	1+	80	2.98	4+	4580	38
		25	0.7	2+	86	2.84	4+	4610	36
		30	0.7	3+	92	2.85	4+	4580	43
Non-mashed, 160kg	50	20	1.0	3+	29	2.86	5+	11360	234
		25	0.9	3+	37	2.14	5+	11310	246
		30	0.8	3+	46	2.84	5+	12000	241
	55	20	0.8	2+	48	2.89	4+	6900	67
		25	0.7	2+	48	2.24	4+	7510	57
		30	0.7	3+	51	2.93	4+	7104	67
	60	20	0.8	2+	81	3.01	4+	4610	41
		25	0.7	2+	81	2.27	4+	4680	30
		30	0.8	3+	99	2.81	4+	4380	39
Mashed, 110kg	50	20	0.8	6+	33	3.01	6+	11980	241
		25	0.8	6+	35	3.02	6+	12560	249
		30	0.8	6+	36	3.04	6+	12900	268
	55	20	0.8	5+	41	308	5+	8010	59
		25	0.7	5+	47	3.05	5+	890	69
		30	0.7	5+	51	3.06	5+	8260	71
	60	20	0.8	5+	77	3.10	5+	5100	42
		25	0.7	5+	73	3.09	5+	5260	47
		30	0.7	5+	76	3.12	5+	5310	53
Mashed, 160 kg	50	20	0.8	6+	37	2.98	6+	11990	247
		25	0.8	6+	39	3.04	6+	12080	251
		30	0.8	6+	46	3.07	6+	12140	249
	55	20	0.8	5+	39	3.05	5+	7950	73
		25	0.7	5+	41	3.06	5+	8390	75
		30	0.7	5+	48	2.99	5+	8430	69
	60	20	0.7	5+	73	3.08	5+	5220	49
		25	0.7	5+	77	3.00	5+	5170	53
		30	0.7	5+	69	3.01	5+	5260	58

The evaluation of both the product output rates and unit costs of the mulberry and apricot and the quality parameters showed that the optimum processing condition, which ensured the highest product output rate and lowest cost in the battery technique for mulberry with desired characteristics, was achieved at a water temperature of 55 ^{0}C with 160 kg of non-mashed fruit loaded in each battery and a battery transition time of 25 minutes.

The analysis results of battery trials on apricot molasses are shown in Table 4.

Since the pomace brix value was found to be higher than the expected in the trial performed with non-mashed apricot, the remaining trials were carried out only with mashed fruit. The microbiological values were high at 50 ^{0}C, and the HMF values were high at 60 ^{0}C. The optimum condition in battery technique for apricot, which ensured the highest product output rate and lowest cost and provided the molasses with desired characteristics, was achieved at a water temperature of 55 ^{0}C with 160 kg of mashed apricot loaded in each battery and a battery transition time of 30 minutes.

Table 4: Results of battery trials on apricot molasses

Fruit	Temperature (^{0}C)	Time (min)	Quality Parameters					Microorganism (Cfu/g)	
			Pomace Brix	Must Turbidity	HMF (mg/kg)	Ash (%)	Sediment	Mesophile	Mold
Non-mashed, 110kg	50	20	9.8	-*	-	-	-	-	-
		25	9.6	-	-	-	-	-	-
		30	9.0	-	-	-	-	-	-
	55	20	8.9	-	-	-	-	-	-
		25	8.5	-	-	-	-	-	-
		30	8.1	-	-	-	-	-	-
	60	20	8.6	-	-	-	-	-	-
		25	8.4	-	-	-	-	-	-
		30	7.9	-	-	-	-	-	-
Mashed, 110kg	50	20	3.6	3+	28	2.98	3+	8270	118
		25	3.3	3+	30	2.98	3+	8320	120
		30	2.9	3+	30	3.01	3+	8420	105
	55	20	3.2	2+	39	2.57	2+	6280	82
		25	2.8	2+	43	2.55	2+	6170	78
		30	2.5	2+	45	2.60	2+	6660	87
	60	20	3.0	2+	68	2.55	2+	3900	33
		25	2.7	2+	71	2.53	2+	3785	36
		30	2.4	2+	69	2.58	2+	3415	43
Mashed, 160 kg	50	20	3.7	3+	29	3.00	3+	7350	110
		25	3.2	3+	32	2.99	3+	8010	130
		30	2.9	3+	38	2.97	3+	8320	119
	55	20	3.2	2+	39	2.61	2+	6190	73
		25	2.9	2+	47	2.61	2+	6240	64
		30	2.4	2+	49	2.75	2+	6510	71
	60	20	3.1	2+	70	2.51	2+	4370	49
		25	2.7	2+	68	2.49	2+	3820	44
		30	2.4	2+	68	2.53	2+	4020	49

*No data was obtained.

3.2. Press Processing Technique

When the product output rates of mulberry and apricot in press technique performed at pilot plant were reviewed, it was seen that increased water temperatures, enzyme dose, fruit ratio and time also increased the product output rate, and that this increase was much higher in mulberry (Table 5).

The unit costs of press trials on mulberry and apricot given in Table 6 shows that the unit costs are associated with the press output rates, and that the lowest unit costs were achieved at a water temperature of 50^{0}C with 75 g/ton enzyme and a fruit:water mixture ratio of 3:7 and a holding time of 30 minutes for both fruits (Table 6).

Table 5. The product output rates in press trials on mulberry and apricot

Temperature (^{0}C)	Enzyme dose (g/ton)	Fruit:Water ratio (w/w)	Product Output Rates (kg/hour) 20 min		25 min		30 min	
			Mulberry	Apricot	Mulberry	Apricot	Mulberry	Apricot
45	50	1:9	128	42	122	38	146	45
		2:8	171	80	171	73	293	87
		3:7	236	118	213	106	439	131
	75	1:9	128	46	142	47	183	51
		2:8	186	86	190	85	293	101
		3:7	279	125	256	120	419	143
50	50	1:9	146	58	142	96	183	112
		2:8	228	105	213	175	244	185
		3:7	278	150	320	250	366	277
	75	1:9	146	122	171	131	244	143
		2:8	256	200	244	229	293	242
		3:7	307	287	366	344	439	337

Table 6. Unit costs of press trials on mulberry and apricot

Temperature (^{0}C)	Enzyme dose (g/ton)	Fruit: Water ratio (w/w)	Unit costs (TL/kg)					
			20 min		25 min		30 min	
			Mulberry	Apricot	Mulberry	Apricot	Mulberry	Apricot
45	50	1:9	0.377	0.495	0.380	0.513	0.370	0.486
		2:8	0.361	0.413	0.362	0.420	0.344	0.404
		3:7	0.356	0.381	0.353	0.388	0.335	0.375
	75	1:9	0.377	0.483	0.371	0.479	0.359	0.465
		2:8	0.358	0.405	0.357	0.406	0.344	0.392
		3:7	0.345	0.378	0.347	0.381	0.335	0.371
50	50	1:9	0.370	0.448	0.254	0.396	0.359	0.385
		2:8	0.351	0.389	0.353	0.351	0.348	0.358
		3:7	0.345	0.368	0.341	0.348	0.338	0.345
	75	1:9	0.370	0.379	0.362	0.375	0.348	0.370
		2:8	0.347	0.355	0.348	0.35	0.344	0.348
		3:7	0.342	0.344	0.338	0.340	0.335	0.340

Table 7 shows the analysis results of mulberry press technique, and Table 8 shows analysis results of apricot press technique. When the quality parameters of mulberry are reviewed, it is seen that the brix in pomace decreases and must turbidity, HMF, ash, sediment and total mesophile and mold amount increases when the water temperature, enzyme dose, fruit ratio and holding time increases. Another important result is that when the water temperature increases from 45^{0}C to 50^{0}C, total mesophile and mold amount decreases significantly.

As a result, taking into consideration the unit costs and that the microbiological values were above the upper limits in all trials performed at a water temperature of 45°C, the must turbidity and sediment were above the upper limits in the trials performed at a water temperature of 50°C with a pressing time of 120 and 180 minutes, and the must turbidity and sediment values were high in the trial performed by use of 75 g/ton enzyme and with a pressing time of 75 minutes, the optimum processing conditions in press technique for mulberry was achieved at a water temperature of 50°C by use of 50 g/ton enzyme with a fruit-water mixture ratio of 2: 8 and pressing time of 60 minutes.

The analysis results of press technique for apricot are shown in Table 8. Table 8 shows that the microbiological values are close to or higher than the upper limit in the trials performed at a water temperature of 45 ^{0}C, and the brix value of the pomace is higher than the expected. The must turbidity and sediment were higher than the upper limit in the trials performed at a water temperature of 50 ^{0}C. The must turbidity and sediment values were again higher in the trial performed by use of 75 g/ton enzyme with a pressing time of 120 minutes.

As a result, taking into consideration the high raw material input and low cost, the optimum processing conditions for apricot in press technique were achieved at a water temperature of 50^{0}C with an enzyme amount of 75 g/ton, fruit:water mixture ratio of 3:7 and pressing time of 60 minutes.

Table 7. Results of mulberry press trial

Temperature (^{0}C)	Enzyme dose (g/ton)	Fruit: Water ratio (w/w)	Time (min)	Quality Parameters						
				Pomace Brix	Must Turbidity	HMF (mg/kg)	Ash (%)	Sediment	Microorganism (Cfu/g)	
									Mesophile	Mold
45	50	1:9	60	0.8	4+	42	3.2	3+	12100	106
			120	0.7	5+	41	3.38	4+	12930	122
			180	0.5	6+	42	3.42	6+	13400	156
		2:8	60	1.2	5+	48	3.4	4+	12980	1.2
			120	1.0	6+	47	3.52	5+	13710	148
			180	0.5	7+	47	3.59	6+	13990	178
		3:7	60	1.3	5+	48	1.48	4+	13500	1.3
			120	1.2	6+	46	3.6	5+	13980	157
			180	0.5	7+	44	3.67	6+	14310	184
	75	1:9	60	0.8	5+	41	3.38	4+	12050	110
			120	0.6	6+	43	3.54	5+	13800	118
			180	0.4	7+	45	3.60	6+	13580	152
		2:8	60	1.1	6+	46	3.52	5+	12970	116
			120	0.9	7+	47	3.62	6+	14050	125
			180	0.5	8+	48	3.72	6+	14220	181
		3:7	60	1.1	6+	47	3.64	5+	13460	140
			120	1.0	7+	50	3.74	6+	14920	162

			180	0.5	8+	52	3.81	6+	14680	198
50	50	1:9	60	0.7	4+	44	3.28	3+	5280	38
			120	0.6	7+	46	3.64	5+	5310	42
			180	0.4	8+	45	3.70	6+	5290	44
		2:8	60	0.9	4+	48	3.42	3+	5460	47
			120	0.8	7+	49	3.72	6+	5500	54
			180	0.6	8+	48	3.78	6+	5420	48
		3:7	60	1.1	6+	52	3.53	5+	5940	54
			120	0.8	7+	55	3.88	6+	6100	60
			180	0.6	8+	53	4.01	7+	5980	61
	75	1:9	60	0.7	5+	43	3.48	4+	5310	34
			120	0.5	8+	47	3.75	6+	5480	37
			180	0.3	9+	46	3.83	7+	5590	41
		2:8	60	0.8	6+	49	3.56	5+	5410	42
			120	0.7	8+	51	3.98	6+	5610	48
			180	0.5	9+	52	4.08	7+	5670	50
		3:7	60	1.0	6+	50	3.67	5+	5710	57
			120	0.7	8+	52	4.10	6+	5800	61
			180	0.5	9+	54	4.17	7+	5920	67

Table 8. Results of apricot press trial

Temperature (^{0}C)	Enzyme dose (g/ton)	Fruit: Water ratio (w/w)	Time (min)	Quality Parameters						
				Pomace Brix	Must Turbidity	HMF (mg/kg)	Ash (%)	Sediment	Microorganism (Cfu/g)	
									Mesophile	Mold
45	50	1:9	60	5.2	2+	32	2.75	2+	6800	91
			120	4.8	3+	34	2.81	2+	6850	93
			180	3.5	4+	36	2.85	3+	6910	97
		2:8	60	5.5	2+	33	2.82	2+	6950	97
			120	5.0	3+	36	2.89	2+	7010	99
			180	3.6	4+	39	2.92	3+	7060	104
		3:7	60	5.6	2+	38	2.84	2+	7210	103
			120	5.2	3+	41	2.93	2+	7270	104
			180	3.6	4+	44	2.97	3+	7480	109
	75	1:9	60	4.8	2+	34	2.79	2+	6810	90
			120	3.9	4+	35	2.76	3+	6960	103
			180	3.1	5+	37	2.81	4+	7040	106
		2:8	60	5.1	2+	36	2.83	2+	6890	95
			120	4.3	4+	38	2.85	3+	6970	107
			180	3.1	5+	41	2.88	4+	7240	112
		3:7	60	5.3	2+	37	2.86	2+	7040	102
			120	4.6	4+	39	2.88	3+	7150	112
			180	3.3	5+	47	2.89	4+	7290	128
50	50	1:9	60	3.8	2+	38	2.76	2+	5030	48
			120	1.9	3+	36	2.81	2+	5140	51
			180	1.4	5+	42	2.87	4+	5260	54
		2:8	60	4.2	2+	42	2.79	2+	5240	53
			120	2.1	3+	44	2.86	2+	5280	54
			180	1.7	5+	47	2.96	4+	5340	55
		3:7	60	4.4	2+	44	2.83	2+	5390	59
			120	2.2	3+	46	2.88	2+	5460	59
			180	1.7	5+	51	3.01	4+	5500	62
	75	1:9	60	1.8	2+	36	2.74	2+	5100	47
			120	1.4	4+	37	2.91	3+	5180	49
			180	1.1	6+	41	2.93	5+	5240	48
		2:8	60	2.2	2+	39	2.81	2+	5360	49
			120	1.6	4+	39	2.99	3+	5310	50
			180	1.3	6+	48	3.01	5+	5400	53
		3:7	60	2.3	2+	43	2.82	2+	5370	57
			120	1.6	4+	45	3.12	3+	5470	55
			180	1.4	6+	54	3.15	5+	5420	58

3.3. Decanter Separator Processing Technique

The trials were performed for mulberry and apricot at pilot plant level. In the trials, the water temperatures were 45 and 50 ^{0}C, the amount of mash enzyme was 50-75 g/ton, the fruit-water mixture ratios were 1: 9, 2:8 and 3:7, mash enzyme holding time was 60 and 120 minutes, and decanter feed rate was 2 and 3 tons /hour. The decantation time also varied depending on the feed rate.

Table 9 shows the yield of trials with decanter separator technique in terms of product output rates. The process time was calculated on the basis of decanter feed rate. The tank used in decanter separator trials was 8.000 kg. The amount of the fruit used was calculated accordingly over the fruit-water ratios, and this value was used in calculation of the raw material input rate. In the decanter separator trial, since 4 personnel worked throughout the trial, the energy consumed was calculated by the ratio of this figure to the process time. These are the amounts of molasses at the end of the process. The ratio of product output rate to raw material input rate shows the yield of the fruit in the trial performed.

Table 10 shows the unit costs. The unit costs of the decanter trial show that the increase in water temperature, enzyme dose, fruit rate and decanter feed rate for the mulberry and apricot resulted in decrease in unit costs. The unit cost values decreased from TL 0.957 TL/kg to TL 0.491/kg in mulberry, and from TL 1.227/kg to TL 0.526/kg in apricot.

Table 11 shows the yields of decanter separator technique for both fruits. Table 11 shows that the yield parameters are associated with the feed rate of the decanter separator rather than the temperature of the water used in extraction, enzyme dose or fruit:water mixture, and that the energy consumed increases as the raw material input rate increases and the process time decreases as the decanter feed rate increases.

Table 9. The product output rates in decanter separator trials on mulberry and apricot

Temperature (^{0}C)	Enzyme dose (g/ton)	Fruit: Water ratio (w/w)	Product Output Rate (kg/hour)			
			2 tons/hours		3 tons/hour	
			Mulberry	Apricot	Mulberry	Apricot
45	50	1:9	47	33	55	41
		2:8	72	62	91	77
		3:7	102	87	122	109
	75	1:9	50	35	61	42
		2:8	81	63	95	79
		3:7	107	90	132	114
50	50	1:9	65	43	73	52
		2:8	100	75	122	92
		3:7	128	104	173	131
	75	1:9	65	47	78	59
		2:8	114	83	122	102
		3:7	142	115	164	144

Table 10. Unit costs of decanter separator trials on mulberry and apricot

Temperature (^{0}C)	Enzyme dose (g/ton)	Fruit: Water ratio (w/w)	Unit Costs (TL/kg)			
			2 tons/hours		3 tons/hour	
			Mulberry	Apricot	Mulberry	Apricot
45	50	1:9	0.957	1.227	0.864	1.050
		2:8	0.734	0.801	0.647	0.706
		3:7	0.613	0.663	0.563	0.593
	75	1:9	0.917	1.176	0.811	1.030
		2:8	0.687	0.794	0.633	0.697
		3:7	0.598	0.562	0.545	0.580
50	50	1:9	0.779	1.026	0.727	0.894
		2:8	0.618	0.718	0.563	0.645
		3:7	0.552	0.606	0.491	0.548
	75	1:9	0.779	0.954	0.703	0.827
		2:8	0.580	0.679	0.563	0.613
		3:7	0.529	0.578	0.501	0.526

Table 11. The yield of decanter separator trial on mulberry and apricot

Temperature (^{0}C)	Enzyme dose (g/ton)	Fruit: Water ratio (w/w)	Decanter Feed rate (ton/hour)	Yield Parameters		
				Raw material input rate (kg/hour)	Process time (hour)	Energy Consumed (personnel/hour)
45	50	1:9	2	133.3	6	0.67
		2:8		267	6	0.67
		3:7		400	6	0.67
	75	1:9		133.3	6	0.67
		2:8		267	6	0.67
		3:7		400	6	0.67
	50	1:9	3	171.3	4.67	0.86
		2:8		343	4.67	0.86
		3:7		514	4.67	0.86
	75	1:9		171.3	4.67	0.86
		2:8		343	4.67	0.86
		3:7		514	4.67	0.86
50	50	1:9	2	133.3	6	0.67
		2:8		267	6	0.67
		3:7		400	6	0.67
	75	1:9		133.3	6	0.67
		2:8		267	6	0.67
		3:7		400	6	0.67
	50	1:9	3	171.3	4.67	0 86
		2:8		343	4.67	0.86
		3:7		514	4.67	0.86
	75	1:9		171.3	4.67	0 86
		2:8		343	4.67	0.86
		3:7		514	4.67	0.86

Table 12 shows the analysis results of the decanter separator technique for mulberry molasses. Of the quality parameters, the brix of pomace slightly increased as the fruit:water ratio and feed rate increased and decreased as the enzyme dose and extraction temperature increased. It was seen that the must turbidity increased due to the increase in the fruit ratio, enzyme amount and extraction temperature. On the other hand, it was found out that extraction at 50 ^{0}C resulted in lower pomace brix when compared to extraction at 45 ^{0}C, and decreased the total mesophile and mold amount, while increasing the must turbidity, HMF, ash and sediment amount. In addition, the increase in ash content, HMF, must turbidity, total mesophile and mold amount was mostly due to fruit ratio and extraction temperature.

Table 12. Results of decanter separator trials on mulberry

Tempera ture (^{0}C)	Enzyme dose (g/ton)	F:W ratio (w/w)	Decanter Feed rate (ton/hour)	Quality Parameters						
				Pomace Brix	Must Turbidity	HMF (mg/kg)	Ash (%)	Sediment	Microorga nism (Cfu/g)	
									Mesophile	Mold
45	50	1:9	2	1.8	6+	45	3.98	6+	11280	98
		2:8		2.3	6+	48	4.04	6+	12020	112
		3:7		2.5	7+	48	4.08	6+	12800	124
	75	1:9		1.7	7+	44	4.01	7+	11850	92
		2:8		2.1	7+	47	4.10	7+	11940	104
		3:7		2.4	8+	51	4.13	7+	12380	131
	50	1:9	3	2.0	6+	42	3.94	6+	11410	84
		2:8		2.4	6+	47	4.02	6+	11980	96
		3:7		2.7	6+	49	4.02	6+	12250	113
	75	1:9		1.8	7+	43	3.98	7+	11360	90
		2:8		2.3	7+	47	4.01	7+	12010	97
		3:7		2.5	7+	48	4.04	7+	12150	128
50	50	1:9	2	1.3	6+	49	4.00	6+	5350	42
		2:8		1.7	7+	53	4.07	7+	5380	48

		3:7		2.0	7+	55	4.11	7+	5470	51
	75	1:9		1.3	7+	50	4.05	7+	5270	40
		2:8		1.5	8+	52	4.11	7+	5300	46
		3:7		1.8	8+	51	4.16	7+	5460	52
	50	1:9	3	1.5	6+	48	4.00	6+	5280	41
		2:8		1.8	6+	54	4.02	6+	5320	44
		3:7		1.9	7+	54	4.08	7+	5350	44
	75	1:9		1.4	7+	49	4.01	7+	5200	42
		2:8		1.8	8+	52	4.04	7+	5310	43
		3:7		2.0	8+	53	4.10	8+	5360	47

As a result, the microbiological values were above the upper limit in the trials performed at a water temperature of 45 ^{0}C by use of 50 and 75 g/ton enzyme. The trial with the lowest must turbidity and sediment value and lowest cost was found to have the optimum processing conditions for mulberry in decanter separator technique with a water temperature of 50 ^{0}C, mash enzyme of 50 g/ton, feed rate of 3 ton/hour and fruit-water mixture ratio of 2:8 (Table 12).

When the analysis results of decanter separator technique for apricot molasses was reviewed (Table 13), it was found out that similar to the mulberry molasses, the brix of pomace slightly increased by the increase in extraction temperature, fruit ratio and feed rate, and decreased by the increase in enzyme dose. The other fruit ratios of 2:8 and 3:7 and the mash enzyme of 75 g/ton was found to result in high must turbidity and sediment values. However, it was found out that extraction at 50 ^{0}C resulted in lower pomace brix when compared to extraction at 45 ^{0}C, decreased the total mesophile and mold amount, while increasing the HMF and ash content. The increases in mesophiles and mold amount in process conditions were found to be due to fruit ratio and extraction temperature.

As a result, the trial with the lowest must turbidity and sediment value and lowest cost was found to have the optimum processing conditions for apricot in decanter separator technique with a water temperature of 50 ^{0}C, mash enzyme of 50 g/ton, feed rate of 3 ton/hour and fruit-water mixture ratio of 1:9.

Table 13. Results of decanter separator trials on apricot

Temperature (^{0}C)	**Enzyme dose (g/ton)**	**F:W ratio (w/w)**	**Decanter Feed rate (ton/hour)**	**Quality Parameters**						
				Pomace Brix	**Must Turbidity**	**HMF (g/kg)**	**Ash (%)**	**Sediment**	**Microorganism (Cfu/g)**	
									Mesophile	**Mold**
45	50	1:9	2	5.3	5+	35	2.89	5+	6530	95
		2:8		5.9	6+	37	2.96	5+	6780	98
		3:7		6.3	6+	39	3.01	5+	6830	101
	75	1:9		5.3	6+	34	2.92	5+	6610	93
		2:8		5.8	6+	35	3.01	6+	6740	99
		3:7		6.1	6+	39	3.09	6+	6790	104
	50	1:9	3	5.8	5+	34	2.80	5+	6590	96
		2:8		6.1	6+	36	2.93	5+	6710	93
		3:7		6.5	6+	35	2.98	5+	6840	102
	75	1:9		5.6	6+	36	2.91	5+	6570	91
		2:8		6.0	6+	32	3.02	6+	6700	102
		3:7		6.2	6+	38	3.06	6+	6840	103
50	50	1:9	2	4.3	5+	38	2.90	5+	4980	39
		2:8		4.9	6+	41	2.98	5+	5120	46
		3:7		5.3	6+	43	3.03	5+	5090	49
	75	1:9		3.9	6+	35	3.06	5+	5160	44
		2:8		4.4	6+	39	3.07	5+	5140	44
		3:7		4.8	6+	37	3.12	6+	5280	50
	50	1:9	3	4.5	5+	37	2.86	5+	5010	43
		2:8		5.1	6+	38	2.93	5+	5090	42
		3:7		5.4	6+	40	2.98	5+	5180	51
	75	1:9		4.0	5+	35	2.99	5+	5110	43
		2:8		4.6	6+	38	3.02	6+	5260	47
		3:7		4.9	6+	40	3.02	8+	5200	51

3.4. Horizontal Extraction Processing Technique

The trials were performed for mulberry and apricot at pilot plant level. The water temperatures used in these trials were 50^{0}C, 55^{0}C and 60 ^{0}C. The amount of fruits used in the trials was 1250 and 2000 kg. The extraction times used were 20, 25 and 30 minutes. The effect of particle size on extraction was measured by trials on mashed and non-mashed fruits. As a result of the trials performed on fruit particle sizes with mashed and non-mashed fruits, it was seen that horizontal extraction system was not suitable for mashed fruit since the mashed fruit in the horizontal extraction system blocked the pores of the system and fruit juice could not be obtained.

The pomace brix and turbidity of the must obtained were measured. HMF, ash, sediment and microbiology analyses were performed on the molasses obtained from this must. The raw material input rate, product output rate, process time, level of energy consumed and cost values were calculated. Firstly, the compliance of the molasses with the codex and then the cost lowness were taken into consideration when determining the optimum values. In addition, the raw material input rate and product output rate are requested to be high, while the process time, the energy consumed and the cost are requested to be low.

Table 14 shows the product output rates of horizontal extraction trial. These are the amounts of molasses at the end of the process. When the product output rates of mulberry and apricot were reviewed, it was seen that the horizontal extraction technique gave close values for both fruits, and that the extraction temperature and amount of fruit increased gradually. However, these increases continued up to 30 minutes in mulberry, while a slight decrease was observed in apricot after an increase up to 30 minutes.

Table 14. The product output rates in horizontal extraction trials on mulberry and apricot

		Product output rates (kg/hour)					
		20 min		**25 min**		**30 min**	
Fruit	**Temperature (^{0}C)**	**Mulberry**	**Apricot**	**Mulberry**	**Apricot**	**Mulberry**	**Apricot**
Non-mashed, 1250 kg	50	213	183	250	185	254	179
	55	229	196	288	212	339	204
	60	229	196	288	215	339	211
Non-mashed, 2000 kg	50	267	280	302	277	371	269
	55	300	293	418	289	480	291
	60	307	293	462	295	509	293
Mashed, 1250 kg	50	-*	-	-	-	-	-
	55	-	-	-	-	-	-
	60	-	-	-	-	-	-
Mashed, 2000 kg	50	-	-	-	-	-	-
	55	-	-	-	-	-	-
	60	-	-	-	-	-	-

*No pertinent data was obtained.

Table 15 shows the yields of horizontal extraction trials on apricot. The calculation of process time was based on the extraction time, and the time for feeding of the fruit to the system was added. The raw material input rate was calculated according to the amount of fruit used. In the horizontal extraction trial, since 3 personnel worked throughout the trial, the energy consumed was calculated by the ratio of this figure to process time. The ratio of product output rate to raw material input rate shows the yield of the fruit in the trial performed. It was found out that the raw material input rate in horizontal extraction technique increases by the fruit amount and increased time, and that it does not change by temperature, while the process time and the energy consumed change in connection with the time.

When the table giving the unit costs of horizontal extraction trial for mulberry and apricot was reviewed (Table 16), it was seen that the unit costs decreased as the extraction temperature and fruit amount decreased in horizontal extraction technique. The decreases observed in extraction time up to 30 minutes in mulberry were observed in apricot up to 25 minutes, and then it was fixed.

Table 15. Yield of horizontal extraction trial on apricot

			Yield Parameters		
Fruit	**Temperature (^{0}C)**	**Time (min)**	**Raw material input rate (kg/hour)**	**Process time (hour)**	**Energy Consumed (personnel/hour)**
Non-mashed, 1250 kg	50	20	417	3	1
		25	385	3.25	0.92
		30	357	3.5	0.86
	55	20	417	3	1
		25	385	3.25	0.92
		30	357	3.5	0.86
	60	20	417	3	1
		25	385	3.25	0.92
		30	357	3.5	0.86
Non-mashed, 2000 kg	50	20	667	3	1
		25	615	3.25	0.92
		30	571	3.5	0.86
	55	20	667	3	1
		25	615	3.25	0.92

	30	571	3.5	0.86
60	20	667	3	1
	25	615	3.25	0.92
	30	571	3.5	0.86

Table 16. The unit costs in horizontal extraction trials on mulberry and apricot

		Unit costs (TL/kg)					
	Temperature (^{0}C)	**20 min**		**25 min**		**30 min**	
Fruit		**Mulberry**	**Apricot**	**Mulberry**	**Apricot**	**Mulberry**	**Apricot**
Non-mashed, 1250 kg	50	0.342	0.345	0.338	0.345	0.338	0.346
	55	0.340	0.344	0.335	0.342	0.333	0.342
	60	0.340	0.344	0.335	0.341	0.333	0.342
Non-mashed, 2000 kg	50	0.337	0.336	0.334	0.336	0.331	0.337
	55	0.335	0.335	0.330	0.335	0.328	0.335
	60	0.334	0.335	0.329	0.335	0.328	0.335
Mashed, 1250 kg	50	-*	-	-	-	-	-
	55	-	-	-	-	-	-
	60	-	-	-	-	-	-
Mashed, 2000 kg	50	-	-	-	-	-	-
	55	-	-	-	-	-	-
	60	-	-	-	-	-	-

*No pertinent data was obtained.

When the conditions of horizontal extraction trial on apricot were reviewed (Table 17), it was seen that the brix of the must remaining in the pomace decreased and the must turbidity, HMF, ash, mesophiles and mold amount increased as the water temperature of extraction and time increased. It was found out that these values increased a bit more when the amount of fruit was increased to 2000 kg in horizontal extraction technique. When evaluated with respect to food codex, microbiological values were close to the upper limit in the trials performed at a water temperature of 50 ^{0}C. The must turbidity was higher in the trials performed with an extraction time of 30 minutes.

Table 17. Analysis results of horizontal extraction trial on apricot

			Quality Parameters						
								Microorganism (Cfu/g)	
Fruit	**Temperature (^{0}C)**	**Time (min)**	**Pomace Brix**	**Must Turbidity**	**HMF (g/kg)**	**Ash (%)**	**Sediment**	**Mesophile**	**Mold**
Non-mashed, 1250 kg	50	20	10.3	3+	28	2.68	2+	7280	98
		25	9.6	3+	30	2.71	2+	7420	102
		30	9.2	3+	32	2.74	2+	7940	104
	55	20	9.8	3+	34	2.76	2+	6820	76
		25	8.3	3+	34	2.79	2+	6880	78
		30	8.0	4+	38	2.80	3+	7020	76
	60	20	9.8	3+	37	2.78	3+	4950	54
		25	8.2	4+	42	2.82	3+	5010	57
		30	7.8	4+	49	3.10	3+	5100	61
Non-mashed, 2000 kg	50	20	10.8	3+	30	2.71	2+	7310	96
		25	10.1	3+	32	2.79	2+	7750	104
		30	9.8	3+	34	2.81	3+	7840	103
	55	20	10.3	3+	36	2.82	3+	6920	78
		25	9.8	3+	40	2.83	3+	7010	85
		30	9.0	4+	44	2.98	3+	7210	87
	60	20	10.3	4+	37	2.88	3+	5060	51
		25	9.6	4+	44	2.94	3+	5120	57
		30	8.9	4+	47	3.11	4+	5340	59

Therefore, the trial with the highest product output rate and lowest cost among the trials with the analysis results that are within the desired range for apricot was found to have optimum parameters with 2000 kg non-mashed fruit, a water temperature of 55 ^{0}C and 20 minutes of extraction time for horizontal extraction technique.

4. Filtration Parameters

Decanter tank, separator, rotary drum filter and ultra-filter filtration techniques were used for the must and molasses obtained by optimum parameters in the battery, press, decanter separator and horizontal extraction techniques for mulberry and apricot, and the parameters giving the lowest must turbidity and molasses sediment were also examined. Each filtration technique was tested with batches of 10 tons, and the labor and material costs were calculated accordingly.

Non-presence of sediment in the molasses is the most important criterion when choosing the optimum values. It is followed by the cost of the technique. Turbidity values were obtained by sensory methods. The sedimentation was determined by taking the mixture, which was prepared by diluting the molasses at a ratio of 1/1, into laboratory tubes of 10 mL and centrifuging it for 15 minutes at 7000 rpm.

Of the four filtration techniques available in the pilot plant where the study was performed, only the separator is used for both must and molasses, while the decanter tank, rotary drum filter and ultra filter are used only for must. Therefore, four techniques were used for must, while one technique was tested for molasses depending on the turbidity of the must.

The amounts of the materials used in filtration techniques were in accordance with the experience of the pilot plant gained over many years, and 35 kg calcium carbonate for apricot and 2 kg bentonite for each fruit were used in the decanter tank, and 25 kg kieselguhr and 200 kg perlite were used for a 10-ton batch of the rotary drum filter.

The labor costs of the techniques were calculated by the number of personnel working for a 10-ton batch and average hourly salary of shift officers and maintenance/repair officers involved in the project. The unit cost was calculated by proportioning the total cost of labor and materials to the batch tonnage.

The must turbidity of mulberry ranges between 2+ and 6+ in the four extraction techniques tested, while the must turbidity of apricot ranges between 2+ and 5+ in the four extraction techniques tested. Although the separator in mulberry and separator and decanter in apricot decreases the turbidity values, these cannot make it zero. The rotary drum filter is also not sufficient for must of both fruits with high turbidity. For a completely clear final product, a molasses separator should be used for both fruits after ultra-filter or a must filtration technique. (Table 19). In terms of unit costs, both must and molasses separation method are equivalent to the use of ultra-filter. It takes 10 hours for a batch of 10 tons to pass through the ultra-filter, while separation take 8 hours in total. Therefore, the optimum filtration method for mulberry and apricot is the separation of both the must and molasses (Table 19).

Table 18. Results of filtration techniques

Processing Technique	Must Turbidity	Must Output				Molasses Output
		Separator	**Decanter tank**	**Rotary Drum Filter**	**Ultra Filter**	**Separator**
Mulberry - battery	2+	2+	-	0	0	0
Mulberry - decanter sep.	6+	4+	-	1+	0	0
Mulberry - press	4+	3+	-	0	0	0
Mulberry - hor. extraction	3+	2+	-	0	0	0
Apricot - battery	2+	2+	2+	0	0	0
Apricot - decanter sep.	5+	3+	4+	1+	0	0
Apricot - press	2+	2+	2+	0	0	0
Apricot - hor. extraction	3+	2+	2+	0	0	0

Table 19. Unit costs of filtration techniques

Unit cost (TL/Kg)	Decanter tank	Separator	Rotary drum filter	Ultra filter
Mulberry	-	2.5	18.05	5
Apricot	23.02	2.5	18.05	5

5. Conclusion

It has been shown that extraction conditions such as water temperature, fruit amount, fruit:water ratio, time and enzyme amount beside the feed rate and capacity of the machine used play an important role on the quality in production of molasses from mulberry and apricot by use of battery, press, decanter separator and horizontal press processing techniques at pilot plant level.

It is possible to produce molasses(pekmez) by various techniques; however, the quality parameters set forth in Turkish Food Codex should be followed and a cost analysis based on raw material input rate, product output rate, process time, the energy consumed should be carried out for determination of the best method and optimum conditions. Within the scope of this study, it has been determined that it is sufficient to check whether the pomace brix, turbidity and sediment amount as must quality parameters in the production of mulberry and apricot molasses, and HMF, mineral substance, sediment and microbiological analysis in the production of mulberry and apricot molasses comply with the limit values set forth in codex or not.

It was shown that the optimum conditions determined in this study vary depending on the molasses production techniques used. Decanter separator processing technique was found to be the best method for production of mulberry and apricot molasses.

However, it was concluded that alone use of the battery, press, decanter-separator and horizontal press processing techniques utilized in the study is not sufficient in the production of mulberry and apricot molasses, and that it is better to include the filtration techniques in combination after production of must and molasses.

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