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Study of Some Physicochemical and Sensory Properties of Apricot Jam Supplemented with Apricot Kernel Flour

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ABSTRACT

New foods with higher nutritional properties are the current trend in various food industries in order to improve nutritional value. The aim of this study was to improve the nutritive quality of the apricot jam (AJ) through a partial substitution of apricot with the flour of apricot kernel at different ratios ranging from 2 to 10 %. The effect of this substitution on the sensory and chemical properties and color characteristics of AJ was studied. The obtained results showed that the AJ prepared from substituted apricot with the kernel flour had higher contents of protein, lipids, and minerals than the control jam, while the control sample showed high contents of moisture, ash, and carbohydrate when compared with the samples prepared from substituted apricot with the kernel flour. Chemical analyzes of apricot seeds have shown a valuable and exciting potential as a food ingredient that is classified as a by-product in apricot-based manufacturing processes, as it enriches AJ with many valuable nutrients that can expand the nutritional base of consumers.

The results of sensory evaluation of AJs supplemented with apricot kernel flour (AKF) showed that the use of AKF at a level 6% improved the characteristics of taste, aroma, and overall acceptance. The apricot kernel can be considered a potential ingredient in industries due to its cost-effective and eco-friendly nature.

Keywords: New foods, Apricot fruit, Jam, Kernels flour, Sensory properties.

Introduction

The apricot fruit (AF) is one of the most important commercial crops around the world, it belongs to *Rosaceae* family, and it plays an important role in human nutrition **(Ruiz *et al.*, 2005 and Ozturk *et al.*, 2009)**. Where AF can be used fresh or processed into apricot juice, nectar, jam, or dried fruit **(Tanwar *et al.*, 2019 and Chen *et al.*, 2023)**. AF is grown in many countries including Egypt, Russia, and the USA. World production of AF reached 4 million tons in 2012. The total area planted with AF in Egypt is about 3931 acres, about 15,724 tons annually (**Omer *et al.*, 2020)**.

AF has a very low shelf life due to the rapid ripening process. To reduce post-harvest losses, many methods and procedures have been devised to preserve the AFs and consume them in the off-season, such as converting them into jam **(Touati *et al.*, 2014 and Lateef *et al.*, 2021)**. As a result, large quantities of apricot pits are produced, which are a by-product of apricot-based manufacturing processes **(Górnaś *et al.*, 2015)**. Which represents 15 – 20 % of the fruit's overall weight **(Tanwar *et al.*, 2018 and Akhone *et al.*, 2022)**. Also, the kernel assimilates 31 to 38% of the pit weight **(Yada *et al.*, 2011 and Rudzińska *et al.*, 2017)**. The apricot kernel (AK) is an important source of oils, polyphenols, flavonoids and cyanogenic glycoside amygdalin **(Zhou *et al.*, 2012; Zhang *et al.*, 2018 and Alajil *et al.*, 2022)**. It has been alleged that bitter AKs can help cure cancer **Hayta & Alpaslan (2011)**. As well as containing a high percentage of antioxidants, vitamins, minerals and proteins **(Kaya *et al.*, 2008 and Vardi *et al.*, 2008)**.

The AKs are categorized as sweet, semi-bitter, and bitter apricot depending on their taste **(Lee *et al.*, 2014)**. The use of bitter kernels AKs for human nutrition compared to sweet kernels was limited, due to their content of the toxic, cyanogenic glycoside amygdalin **(Gómez *et al.*, 1998)**.

In Egypt, large amounts of apricot pits remain after processing and representing the by-products, accumulating after processing of apricot juice, nectar, jam, and pulp in brine or in syrup and sheets or utilized fresh. Currently, even now, there is no organized method of collection and using apricot pits **(Mostafa & Aly 2014)**. As mentioned above, the nutritional and functional composition of the AK is a very important factor in determining its compatibility with use in various value-added food products. Based on the above, the current study aims to:

1. Raise the nutritional value of AJ by partially substituting apricots with flour extracted from AKs.
2. Study of some the physical properties and chemical compositions of AF, AK, and AJ supplemented with AKF.

Materials and Methods

2.1. MATERIALS

AFs were purchased from the local market (Aswan-Egypt). AFs were washed with clean running tap water followed by manual removal of pits (seeds). The apricot flesh was then washed with clean running tap water and maintained under cooling conditions at 4 ± 1°C until use. The AKs were obtained by manually cracking the seeds.

2.2. Methods

2.2.1. Detoxification of AKs

The outer coat of kernels was manually removed after the kernels had been soaked in distilled water for 1 h at 45 ± 2°C. In order to eliminate the toxic substances and the bitterness present in the AKs, a step of detoxification and debittering was carried out before their use, according to **Gupta and Sharma, (2009)** with some modifications. The AK (100 g) was stored for 12 hours after being submerged in 500 mL of a 25% sodium chloride (NaCl) solution. Then, the kernels were carefully rinsed under running water until the water was clean. The kernels were re-soaked overnight at 40 ± 2°C in distilled water with a ratio of 1:12 (w/w), as shown in Fig. 1.

2.2.2. Preparation of AKF

The flour extracted from AK was prepared according to **Özboy-Özbaş *et al.*,**

(2010) and **Dhen *et al.*, (2017)**. The detoxified and de-bittered AKs were hot air-dried at 40°C for 36 h and then ground by a kitchen grinder. The AK flour was then sieved by a 60-mesh sieve and stored at cooling conditions (at 4 ± 1°C) until use as shown in Fig. 1.

2.2.3. Prepare AJ samples

AJ was prepared according to **Jannika *et al.*, (2022)** and **Sheet, (2022**) experiments were conducted in the Faculty of Agriculture and Natural Resources, Aswan University, in department of Food Science and Technology. The AFs flesh (pulp) was chopped into small pieces by using a kitchen knife. For preparing the standard sample, the apricot pieces were placed in an open stainless-steel pan, with sufficient amount of water and to prevent oxidation, 300 mg of citric acid per kilogram of pulp was added. The ratio of sugar was 700 g per kg of pulp. In a stainless-steel pan, the pulp was added along with only 10% of the calculated sugar, and it was continuously stirred as it boiled. After half an hour, when the pulp reached approximately 35 – 40 ◦Brix, the remaining sugar was then added, reaching the final point of approximately 65◦ Brix after 45 min. After that, taken out of the heat, slightly warmed, and packed into clean, dry sterilized glass containers, closed tightly, and left to cool in a refrigerator at 4 °C ± 1. This results in a light colored, AJ. Then, five groups of AJ were prepared by replacing AJ with AKF at levels of 2%, 4%, 6%, 8% and 10%, as shown in Fig. 1.

2.3. Proximate chemical composition of apricot, AKs, and AJ samples

2.3.1. Acidity

Acidity (expressed as % malic acid) was determined by using (0.1 N) NaOH and phenolphthalein as an indicator according to **Horwitz (2010)**, as shown in eq. 1.

%Acidity= volume of treated NaOH X 0.1 X 67.05 / Weight of sample (1)

2.3.2. pH Value

The pH value was estimated for extracted samples by using a digital pH meter according to **Horwitz (2010)** Methods.

2.3.3. Total Soluble Solids (TSS)

Total soluble solids (% TSS) were expressed as °Brix (0 - 90) for extracted samples using digital Refractometer at room temperature (27 °C ± 1) according to **Horwitz (2010)**.

2.3.4. Caloric value

Calorie value (kcal /100 g) was calculated based on calorie parameters according to protein, carbohydrate and fat contents, as shown in eq. 2, according to **Coelho & de las Mercedes (2015)**.

Caloric value = (proteins (g)× 4) + (lipids (g) × 9) + (carbohydrates(g) × 4) … (2)

2.3.5. Determination of moisture

The moisture content was assessed using heating samples at 60 ± 1 °C overnight in a hot air oven, according to the method which described by **Horwitz (2010)**.

2.3.6. Determination of ash

Ash was determined in samples using Muffle Furnace at 550 °C for 3 hr according to the method reported by **Horwitz (2010)**.

2.3.7. Determination of protein

Total nitrogen of samples was determined by Micro-Kjeldahl apparatus as described in **Horwitz (2010)**, as shown in eq. 3.

Protein = 6.25 × % nitrogen … (3)

2.3.8. Determination of fat (lipid)

Fat (Lipid) was estimated according to **Horwitz (2010)** using Soxhalet apparatus (petroleum ether).

2.3.9. Determination of crude fiber

Crude fiber was estimated according to **Horwitz (2010)** using fiber analyzer.

2.3.10. Determination of carbohydrates

The carbohydrate (%) of jam can be calculated according to the following equation **Horwitz (2010)**.

Carbohydrates (%) = 100 – [Moisture (%) +Lipid (%) + Protein (%) + Ash (%)] ….(4)

2.3.11. Determination of mineral content

The procedure was carried out in accordance with the approach outlined by **Horwitz (2010)**. Each sample's known weight of ash was completely dissolved in an HCL solution. (1 N) and quantitatively transferred into volumetric flask and completed to 100 ml with HCL, Magnesium (Mg), Calcium (Ca), Iron (Fe), Sodium (Na), and Zinc (Zn) were calculated in the digested solution using atomic absorption apparatus (PUG 100X series Atomic Absorption Spectrophotometers).

2.3.12. Determination of vitamin (C)

The vitamin (C) was determined according to **Ross (1994)**. (0.5 mL) liquid sample and (0.5 mL) of 10% meta-phosphoric acid were mixed for (5 min) was using a vortex (final concentration of meta-phosphoric acid was 5%), centrifuged for 10 min at 8500g, and injected onto the HPLC or UPLC column to determine ascorbic acid (AA) content.

2.4. Physical properties of apricot, AKs, and AJ samples

2.4.1. Color measurement

The samples' color values (L*, a*, and b*): were assessed using a colorimeter that had been previously calibrated using a black-and-white reference. There were at least three replications of the analysis, according to **Sahingil and Hayaloglu (2021)**.

The samples' hue angle: ranges from 0° (pure red), 90° (pure yellow), 180° (pure green), and 270° (pure blue), according to **Seerangurayar *et al*., (2019)**, as shown in eq. 5.

$$\text{Hue angle (H)} = \arctan\left(\frac{b^*}{a^*}\right) \quad \dots (5)$$

Total color change (ΔE^*): The following formulas were used to compute the total color change (E*) in accordance with **Nkhata (2020)**, as shown in eq. 6.

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} \quad \dots (6)$$

Where: $\Delta L^*, \Delta a^*, and\ \Delta b^*$represent changes in lightness, redness, and yellowness, respectively, after manufacturing process.

Chroma: indicating color intensity, as shown in eq. (7).

$$C^* = \sqrt{(a^*)^2 + (b^*)^2} \quad \dots (7)$$

Where: a* and b* represent values after manufacturing process.

2.5. Sensory evaluation:

Samples of AJ were sensory-evaluated after preparation and cooling, according to the procedures outlined in **(Basu *et al*., 2011)** using a 10-member panel randomly selected from teaching staff in Faculty of Agriculture and Natural Resources - Aswan University. A coded method was used to package the samples of AJ in a clear bottle. The sample's taste, aroma, color, mouthfeel, and overall acceptability were its sensory quality components.

2.6. Statistical analysis

Using IBM SPSS Statistics 25, PC statistical software, and Excel 365, the received data's statistical analysis was completed. The mean and standard deviation of the mean were used to express all the data (S.D.). LSD Multiple Range Test was applied to estimate significant differences between means values at 5% levels of probability. All experiments were repeated at least three times **(Montgomery, 2017)**.

3. RESULTS AND DISCUSSION

3.1. Chemical Composition and caloric value

3.1.1. Approximate Chemical Composition

The study of chemical composition of the AFs and the AKF is the first step in the evaluation of the nutritive value of the different formulations of the AJ and thus the determination of the caloric value of these formulations. Table 1 shows the chemical composition of the fresh AFs, AKF, and the different formulations of the AJ. The moisture content of fresh AFs and the AKF was found to be 82.16 and 4.27g /100 g wet basis, respectively. The obtained results show that the AJ formulations prepared from the apricot substituting with the AKF had lower moisture content than the control sample; where the moisture content of AJ (control sample) was 26.42 g /100 g wet basis, while the moisture content of different formulations of the AJ varied from 22.92 to 25.44 g/100 g wet basis. Besides, a gradual decrease in the moisture content of AJ, prepared from the apricot substituting with AKF, was observed as the substitution ratio increased. The highest decrease (13.2%) was observed for the formulation prepared with 10 % as a substitution ratio for the apricot with AKF, compared to the control sample. The obtained results are in agreement with that reported by

Dhen *et al*., (2018) who found a gradual decrease in the moisture content of wheat flour bread fortified with AKF as the fortification ratio increased. The decrease in the moisture content of the different formulations may be due to the substitution with AKF which had a lower moisture content compared to the fresh AFs, being 4.27 versus 82.16 g /100 g wet basis.

Regarding the content of protein, the protein content of fresh AFs and the AKF was found to be 1.54 and 24.48 g/100 g wet basis, respectively. These results were in line with **(Mostafa & Aly 2014)** who found protein content in AKF is 25.3%. On the other hand, the protein content of AJ (control sample) was 0.52 g/100 g wet basis, while the protein content of different formulations of the AJ ranged between 0.53 to 0.61 g/100 g wet basis (Table 1). The obtained results show that the AJ formulations prepared from the substitution of apricot with the AKF had higher protein content than the control sample, where raising the substitution ratio was found to gradually enhance the protein content. That is to say, the AKF could serve as a strong source of protein and added in some components of food to raise its value **(Liu, & Zhang, 2022).**

Concerning the lipid content, specking ash, the obtained results in Table 1, showed that there is no significant difference between AJ at 4%, and 6%of AKF on another hand there was a significant increase was noted when using 8% and10% of AKF replacement. This is due to the fact that AKF contains high levels of minerals **(Hayta, & Alpaslan, 2011 and Dhen *et al*., 2018)**.

In comparison to the control sample, AJs had been supplemented with AKF had a higher protein level. This increasing trend was significant in the AJ samples supplemented with 8% and 10% of AKF.

The increase in lipid (fat) content was observed in all AJ samples supplemented by AKF. Since fat content is a flavor reservoir for food (volatile compounds), it may improve the flavor of enriched AJ because it can affect how flavor and texture are perceived and last longer in the mouth **Lee *et al*., (2005)**.

The variation in carbohydrate content in all AJ samples can be ascribed to the variations in other items' contents because it was calculated based on difference. Also, we found that AKF addition reduced carbohydrate content, and lead to decrease carbohydrate content in all AJ's samples. Respecting carbohydrate content, the results in Table 1, show that there is no significant difference between all AJ's samples. Customers may need this jam product for a variety of factors, including nutrition value, health advantages, and body weight maintenance **Mohamed *et al*., (2006)**.

3.1.2. Caloric value

Results in Table 2 showed that caloric value increases from 314.09 to 336.17 kcal/100 g with increasing AKF level up to 10%, as a result of the lipid and protein increase. Also, there was no significant difference between AJ at 8%, and 10% of AKF.

Acidity

A food product's stability and shelf life are determined by its acidity. The organic acids found naturally in fruits and those added during jam manufacturing give jam its acidity value **Kanwal *et al*., (2017)**. Acidity of all levels of AKF was increased during the process from 1.027 at level 2 % to 1.031 at level 10 %. The increase in acidity value may be due to degradation of polysaccharide, acid formation, and oxidation of reducing sugars or by break down of pectin into pectic acid **Bolarinwa *et al*., (2014)** and **Kanwal *et al*., (2017)**.

pH value

The pH value of a jam and food is directly related to the free hydrogen ions and change in acidity of samples. The pH of jam is an important factor to obtain optimum gel condition **Kanwal *et al*., (2017)**. The pH values for AJ observed in different samples are listed in Table 2. The data showed that the pH of the different levels of AJ ranged from 3.29 to 3.30 which are within the recommended limits of 3.0 to 3.5 for jam **(Chalchisa *et al*., 2022 and**

Sheet, 2022). This change in pH value in jam may be due to the formation of acidic compounds **Kanwal *et al*., (2017)**. Similarly, reduction in pH of jam prepared from grapefruit and apple was reported by **Shakir *et al*., (2007)**.

TSS

TSS of AF, AJ, and AJ supplemented with AKF are given in the Table 2. Generally, there was a gradual increase in TSS with a level up of AKF. Data shows that TSS ratio of fresh AF was 26.47 ± 1.56 °Brix that was increased up to 69.35 ± 0.16 °Brix increasing AKF level up to 10%. In the current study, the TSS of the AJs showed significant ($p < .05$) differences among each other due to the sugar and pectin concentration **Chalchisa *et al*., (2022)**. Also, Increase in TSS may be due to acid hydrolysis of polysaccharides especially pectin **Kanwal *et al*., (2017)**.

Vitamin C

AA is sensitive to heat, light and vitamin C is lost during cooking at high temperatures **Kanwal *et al*., (2017)**. Also, as a result of adding AKF with a low content of vitamin C to AJ, it led to a decrease in the content of vitamin C in the AJ in all samples where the lowest value of vitamin C was observed with AJ sample supplemented with 10%. AA decomposition could occur anaerobically after the chemical reactions have used all the oxygen that was ingested; to create furfural AA steps up the severity under the anaerobic conditions **Abbas *et al*., (2021).**

3.2. Mineral composition

The results in Table 3 showed the minerals content Mg, Ca, Na, Fe, and Zn in AF, AK, and all AJ samples. It is obvious from the tabulated data that AK was contained a higher amount of all minerals compared with AF except Fe. The minerals content results of AKF agree with previous findings by **Liu, & Zhang, (2022)** who reported that AKF found to be good sources for minerals like Fe, Ca, P and Mg.

The higher values of all minerals content were observed in AJ sample supplemented with 10 % while the lowest values were observed in AJ sample supplemented with 2 %. The highest level of Mg and Ca was (14.74 mg/100g) and (21.87 mg/100g), respectively. The results of Mg and Ca show that there is no significant difference between all AJ's samples. Magnesium is essential for maintaining the body's acid-alkaline balance and for maintaining enzyme activity. **Nzikou *et al*., (2010)**. Calcium is important for bone building, enzyme activity and nucleic acids metabolism **Heaney, (2001)**.

Regarding Na, Fe and Zn, AJ sample supplemented with 10 %showed superior values compared with the other AJ samples (17.32 mg/100g), (0.47 mg/100g) and (0.45 mg/100g), respectively. Iron is essential for blood formation and synthesis of amino acids and proteins **(Kittiphoom, 2012)**.

3.3. Color analysis of AJ

A dominant Quality of the AJ without AKF and AJ supplemented with AKF could be judged by color analysis. For each AJ, the color values (L*, a*, and b*) of the samples were measured using a colorimeter as shown in Table 5.

The results shown in Table 4, show that the average value of L* for AJ without AKF was 29.13, but after supplementing AJ with AKF showed a little change compared to before adding AKF for all Jam Samples. The a* values for AJ samples under the different percentages of AKF were low which indicates a tendency of AJ samples to have more of a yellowness color rather than redness.

Hue angle (H), values of the AJ samples were above 48.05 º, showing a very clear transition from red into yellow. Table 4 shows that all values of H after supplementing AJ with AKF were higher than before drying.

Changes in chroma, which defines color intensity (higher values signify a more vivid color), followed a similar trend to changes in parameter a*. In the AJ sample, chroma (*C**) increased from 6.94 to 8.85 as shown in the following Table 4. It was found that total color change (ΔE*) increases with increasing percentage of AKF in AJ.

3.4. Sensory Attributes

The overall acceptability of different formulations of the AJ was based on the evaluation of their taste, aroma, color, and mouthfeel. Figure 2 shows the sensorial attributes of different formulations of the AJ. In the control sample, the formulations prepared from 2 and 6 % as a substitution ratio for the apricot with AKF showed the highest overall acceptability (8.63). Furthermore, the formulation prepared from 2 % as a substitution ratio for the apricot with AKF showed the highest score for the taste and the color (9.00) followed by the formulation prepared with 6 % as a substitution ratio for the apricot with AKF with a score of 8.63 for the color. On the other hand, the control sample and the formulation prepared with 2 % as a substitution ratio for the apricot with AKF showed the highest score for the mouth feel with a score of 8.63. While the control sample and the formulation prepared with 6 % as a substitution ratio for the apricot with AKF showed the highest score for the aroma with a score of (8.75).

4. CONCLUSION

Results demonstrated that enriched AJ was prepared by partially substituting AF with AKF. As a by-product, apricot kernels offer an exciting new potential as a food ingredient to improve AJ and enlarge the food base for Egyptian consumers. Up to 8% of AF replacement with AKF is an effective way to supplement AJ with protein, lipids, and minerals without altering its desirable physical and textural properties. The use of AKF at a level above 8% is not recommended, since it resulted in an undesirable change of taste, aroma, mouthfeel, and overall acceptance of AJ in general. In future works, an investigation of the effect of AKF on enriched AJ structure, and physical changes during storage would be interesting. Therefore, still, AK is a great source of research as it has excellent techno-functional, especially in the food and pharma industries. The AK can be used in the preparation of low-fat biscuits, cookies, cakes, and the fabrication of antimicrobial films.

Competing interests

The author(s) declare no competing interests.

Ethics Committee

The study has the approval of the Scientific Research Ethics Committee of New Valley University **no. NVREC 03/3/ 6-2023/6**.

List of Abbreviations

AA	**Ascorbic acid**
AF	Apricot fruit
AJ	Apricot jam
AK	Apricot kernel
AKF	Apricot kernel flour
TSS	Total Soluble Solids

Table (1): Chemical composition* of AF, AK, and AJ samples (1 of 2)

Jam sample	Moisture (g/100 g)	Ash (g/100 g)	Protein (g/100 g)	Lipid (g/100 g)	Total carbohydrate (g/100 g)
AF	82.16 ± 2.39	2.49 ± 0.27	1.54 ± 0.05	0.49 ± 0.01	13.32 ± 1.28
AK	4.27 ± 0.23	2.35 ± 0.19	24.48 ± 2.02	51.08 ± 3.01	17.82 ± 0.97
AJ	26.42 ± 1.88 a	0.62 ± 0.10^{bc}	0.52 ± 0.03^{def}	3.67 ± 0.06^{e}	69.76 ± 1.5^{ab}
AJ + 2 % AKF	$25.44 \pm 1.44^{ab**}$	0.55 ± 0.07^{cdef}	0.53 ± 0.04^{cde}	4.13 ± 0.07^{d}	71.62 ± 0.85^{a}
AJ + 4 % AKF	23.17 ± 0.99^{bcde}	0.58 ± 0.04^{cd}	0.56 ± 0.03^{bcd}	4.83 ± 0.08^{c}	67.61 ± 1.98^{bcde}
AJ + 6 % AKF	24.24 ± 1.48^{abc}	0.56 ± 0.04^{cde}	0.57 ± 0.02^{abc}	5.01 ± 0.10^{bc}	69.62 ± 1.42^{abc}
AJ + 8 % AKF	23.84 ± 1.0^{bcd}	0.67 ± 0.03^{b}	0.61 ± 0.02^{a}	5.11 ± 0.11^{b}	69.76 ± 1.06^{ab}
AJ + 10 % AKF	22.92 ± 0.98^{cdef}	0.78 ± 0.03^{a}	0.60 ± 0.01^{ab}	6.20 ± 0.09^{a}	69.50 ± 0.89^{abcd}

Each value is expressed as mean values ± standard deviation (n = 3).
* Dry matter basis. ** Means in the same row with different letter combinations (a, b, c, and d) differ significantly at p 0.05, whereas those with comparable letter combinations do not differ significantly.

Table (2): Chemical composition* of AF, AK, and AJ samples (2 of 2)

Jam Sample	Caloric value (kcal/100 g)	% Acidity	pH	TSS	Vitamin (C)
AF	63.85 ± 2.35	1.025 ± 0.125	5.35 ± 0.56	26.47 ± 1.56	9.71 ± 0.65
AK	628.92 ± 6.87	0.927 ± 0.089	3.64 ± 0.37	N.D.***	1.97 ± 0.02
AJ	314.09 ± 5.97^{ef**}	1.027 ± 0.03 ^{abcd}	3.29 ± 0.03^{acef}	68.69 ± 0.21^{bc}	7.51 ± 0.07^{a}
AJ + 2 % AKF	325.78 ± 3.97^{bcd}	1.014 ± 0.01^{ef}	3.32 ± 0.03^{acd}	68.77 ± 0.11 ^{b}	7.43 ± 0.05^{ab}
AJ + 4 % AKF	316.13 ± 7.26 ^{cde}	1.022 ± 0.01^{abcde}	3.33 ± 0.07^{ab}	67.92 ± 0.12 ^{d}	7.37 ± 0.07 ^{bc}
AJ + 6 % AKF	325.87 ± 6.57^{bc}	1.028 ± 0.01^{abc}	3.35 ± 0.08 ^{a}	66.62 ± 0.09^{f}	7.37 ± 0.08 ^{bc}
AJ + 8 % AKF	327.50 ± 3.78^{ab}	1.029 ± 0.01^{ab}	3.37 ± 0.04^{abc}	67.36 ± 0.96 ^{e}	7.01 ± 0.06 ^{d}
AJ + 10 % AKF	336.17 ± 4.39 ^{a}	1.031 ± 0.02^{a}	3.39 ± 0.03^{bcde}	69.35 ± 0.16 ^{a}	6.98 ± 0.04^{de}

Each value is expressed as mean values ± standard deviation (n = 3).
* Dry matter basis.
** Means in the same row with different letter combinations (a, b, c, and d) differ significantly at p 0.05, whereas those with comparable letter combinations do not differ significantly.
***N.D. means not detected.

Table (3): Minerals content * of AF, AK, and AJ samples

Jam Sample	Magnesium (Mg)	Calcium (Ca)	Sodium (Na)	Iron (Fe)	Zinc (Zn)
AF	10.33 ± 0.25	25.37 ± 1.42	26.31 ± 2.39	14.73 ± 0.97	0.75 ± 0.01
AK	134.43 ± 2.34	153.29 ± 5.34	29.78 ± 1.08	2.94 ± 0.21	4.92 ± 0.87
AJ	3.97 ± 0.05 $^{f\,**}$	7.27 ± 0.09^{f}	14.80 ± 0.51^{ef}	0.22 ± 0.02^{ef}	0.04 ± 0.0 ^{f}
AJ + 2 % AKF	5.45 ± 0.07^{e}	8.88 ± 0.23^{e}	15.16 ± 0.48^{e}	0.25 ± 0.03^{e}	0.11 ± 0.01^{e}
AJ + 4 % AKF	7.89 ± 0.08^{d}	11.40 ± 0.25 ^{d}	15.99 ± 0.25^{cd}	0.32 ± 0.01^{cd}	0.17 ± 0.02^{d}
AJ + 6 % AKF	9.77 ± 0.07^{c}	15.79 ± 0.17^{c}	16.19 ± 0.08^{c}	0.39 ± 0.03^{c}	0.31 ± 0.02^{c}
AJ + 8 % AKF	13.07 ± 0.08^{b}	17.46 ± 0.42^{b}	16.87 ± 0.14^{ab}	0.42 ± 0.02^{ab}	0.35 ± 0.02^{b}
AJ + 10 % AKF	14.74 ± 0.15^{a}	21.87 ± 0.91^{a}	17.32 ± 0.31^{a}	0.47 ± 0.03^{a}	0.45 ± 0.01^{a}

Each value is expressed as mean values ± standard deviation (n = 3).

* Dry matter basis.

** Means in the same row with different letter combinations (a, b, c, and d) differ significantly at p 0.05, whereas those with comparable letter combinations do not differ significantly.

Table (4): Color characteristics of different jam formulations

Jam Formulation	*L**	*a**	*b**	*C**	*ΔE*	*H °*
AJ (control)	29.13±0.16^{f}	4.49±0.10^{e}	5.29±0.11^{f}	6.94±0.10^{f}	0.00±0.0^{f}	49.68 ±0.09^{e}
AJ + 2 % AKF	30.19±0.15^{e}	4.72±0.10^{d}	5.84±0.10^{e}	7.51±0.11^{e}	1.22±0.10^{e}	51.05 ±0.11^{d}
AJ + 4 % AKF	30.42±0.13^{d}	4.91±0.11^{c}	6.08±0.13^{d}	7.82±0.11^{d}	1.57±0.09^{d}	51.08 ±0.10^{cd}
AJ + 6 % AKF	30.76±0.11^{c}	5.08±0.10^{b}	6.32±0.11^{c}	8.11±0.10^{c}	2.02±0.07^{c}	51.21 ±0.08^{c}
AJ + 8 % AKF	31.43±0.14^{b}	5.14±0.12^{b}	6.64±0.13^{b}	8.40±0.12^{b}	2.74±0.10^{b}	52.26 ±0.09^{b}
AJ + 10 % AKF	31.82±0.12^{a}	5.36±0.11^{a}	7.60±0.11^{a}	9.30±0.10^{a}	3.65±0.08^{a}	54.81 ±0.08^{a}

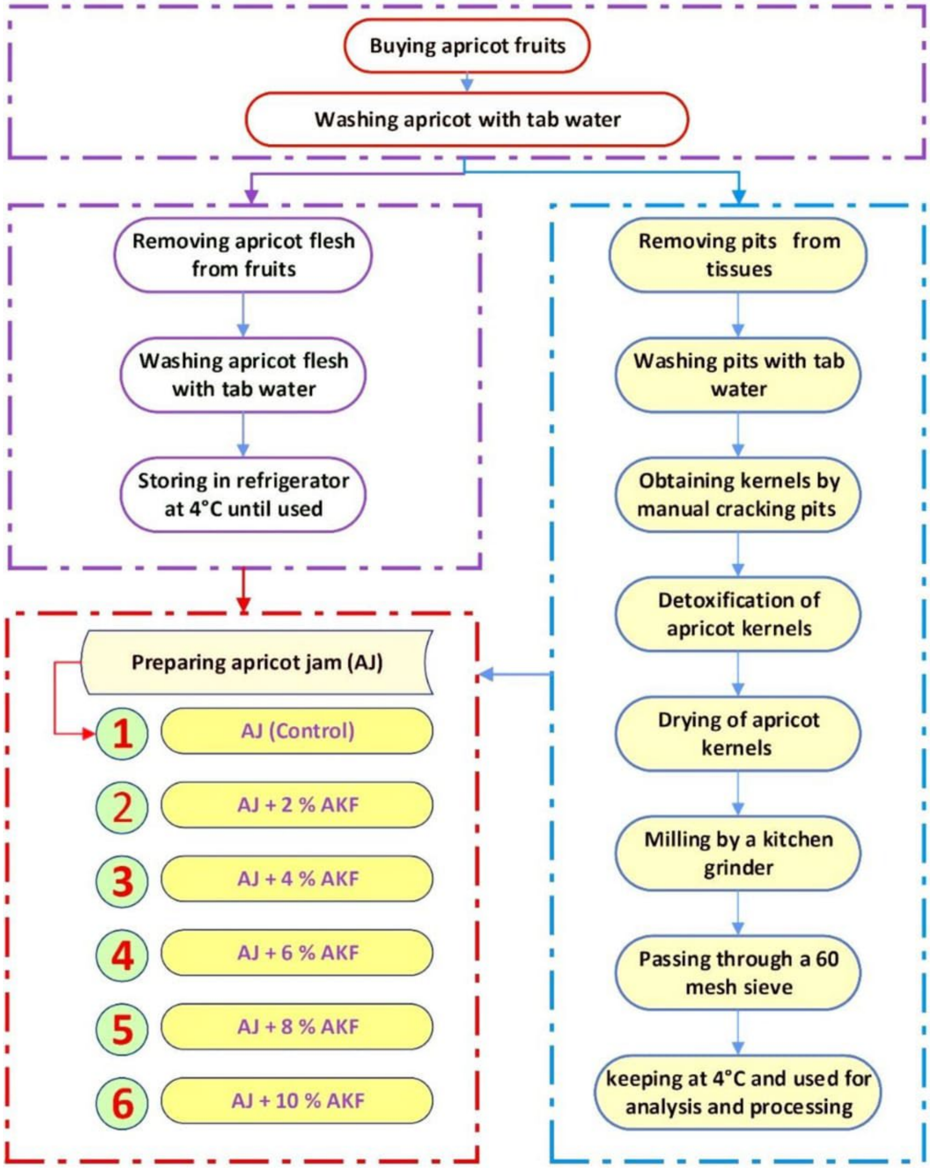

Figure (1): Flow chart showing the steps for making AJ

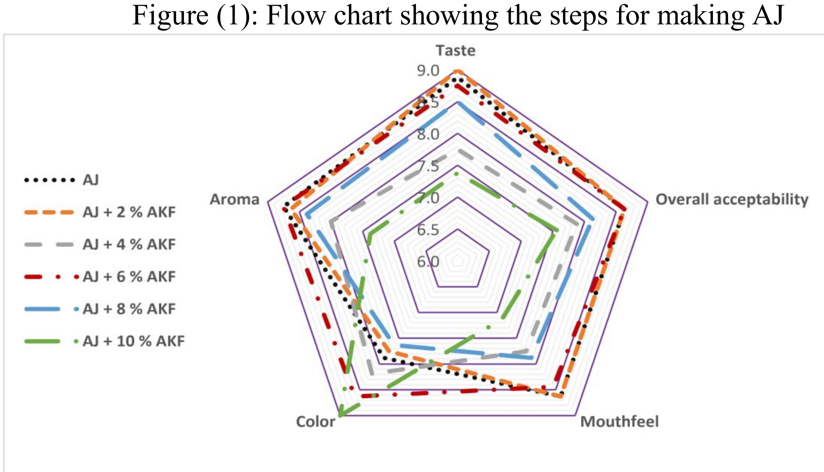

Figure (2): Sensory attributes of different formulations of the AJ

5. REFERENCES

Abbas, Z., Mazahir, M., Mehdi, A., Sohail, A., Asim, M., Ali, W., & Muhammad, S. B. (2021). 26. Quality assessment of apricot jam supplemented with Sea buckthorn pulp. Pure and Applied Biology (PAB), 10(3), 826-834.

Akhone, M. A., Bains, A., Tosif, M. M., Chawla, P., Fogarasi, M., & Fogarasi, S. (2022). Apricot kernel: Bioactivity, characterization, applications, and health attributes. *Foods*, *11*(15), 2184.

Alajil, O., Sagar, V. R., Kaur, C., Rudra, S. G., Vasudev, S., Chandran, D.,... & Lorenzo, J. M. (2022). Chemical Characterization of Apricot Kernel: Nutraceutical Composition, Amino Acid, and Fatty Acid Profile. *Food Analytical Methods*, *15*(9), 2594-2604.

Basu, S., Shivhare, U. S., Singh, T. V., & Beniwal, V. S. (2011). Rheological, textural and spectral characteristics of sorbitol substituted mango jam. *Journal of Food Engineering*, *105*(3), 503-512.

Bolarinwa, I. F., Orfila, C., & Morgan, M. R. (2014). Amygdalin content of seeds, kernels and food products commercially-available in the UK. *Food chemistry*, *152*, 133-139.

Chalchisa, T., Zegeye, A., Dereje, B., & Tolesa, Y. (2022). Effect of Sugar, Pectin, and Processing Temperature on the Qualities of Pineapple Jam. *International Journal of Fruit Science*, *22*(1), 711-724.

Chen, Y., Li, W., Jia, K., Liao, K., Liu, L., Fan, G.,... & Wang, Y. (2023). Metabolomic and transcriptomice analyses of flavonoid biosynthesis in apricot fruits. *Frontiers in Plant Science*, *14*.

Coelho, M. S., & de las Mercedes Salas-Mellado, M. (2015). Effects of substituting chia (Salvia hispanica L.) flour or seeds for wheat flour on the quality of the bread. *LWT-Food Science and Technology*, *60*(2), 729-736.

Dhen, N., Rejeb, I. B., Martínez, M. M., Román, L., Gómez, M., & Gargouri, M. (2017). Effect of apricot kernels flour on pasting properties, pastes rheology and gels texture of enriched wheat flour. *European Food Research and Technology*, *243*, 419-428.

Dhen, N., Rejeb, I. B., Boukhris, H., Damergi, C., & Gargouri, M. (2018). Physicochemical and sensory properties of wheat-Apricot kernels composite bread. *Lwt*, *95*, 262-267.

Gómez, E., Burgos, L., Soriano, C., & Marín, J. (1998). Amygdalin content in the seeds of several apricot cultivars. *Journal of the Science of Food and Agriculture*, *77*(2), 184-186.

Górnaś, P., Mišina, I., Grāvīte, I., Soliven, A., Kaufmane, E., & Segliņa, D. (2015). Tocochromanols composition in kernels recovered from different apricot varieties: RP-HPLC/FLD and RP-UPLC-ESI/MSn study. *Natural Product Research*, *29*(13), 1222-1227.

Gupta, A., & Sharma, P. C. (2009). Standardization of technology for extraction of wild apricot kernel oil at semi-pilot scale. In *Biological Forum–An International Journal* (Vol. 1, No. 1, pp. 51-64).

Hayta, M., & Alpaslan, M. (2011). Apricot kernel flour and its use in maintaining health. In *Flour and breads and their fortification in health and disease prevention* (pp. 213-221). Academic press.

Heaney, R. P. (2001). Calcium needs of the elderly to reduce fracture risk. *Journal of the American College of Nutrition*, *20*(2), 192S-197S.

Horwitz, W. (2010). *Official methods of analysis of A.O.A.C. International. Volume I, agricultural chemicals, contaminants, drugs/edited by William Horwitz*. Gaithersburg (Maryland): A.O.A.C. International, 1997.

Jannika, B., Pablo, M., Silvia, F., Tatiana, F., & Emilia, R. (2022, February). Development of Jams with Ancestral Seed Aggregates.

In *Biology and Life Sciences Forum* (Vol. 8, No. 1, p. 9). MDPI.

Kanwal, N., Randhawa, M. A., & Iqbal, Z. (2017). Influence of processing methods and storage on physico-chemical and antioxidant properties of guava jam. *International Food Research Journal*, *24*(5).

Kaya, C., Kola, O., Ozer, M. S., & Altan, A. (2008). Some characteristics and fatty acids composition of wild apricot (*Prunus pseudoarmeniaca* L.) kernel oil. *Asian Journal of Chemistry*, *20*(4), 2597.

Kittiphoom, S. (2012). Utilization of mango seed. *International Food Research Journal*, *19*(4).

Lateef, M. A. A., Fadhil, N. N., & Mohammed, B. K. (2021, November). Effect of Spraying With Cal-Boron and Potassium Humate and Maturity Stage on Fruit Quantity, Quality Characteristics of Apricot Prunus Armeniaca L. cv." Royal". In *IOP Conference Series: Earth and Environmental Science* (Vol. 910, No. 1, p. 012038). IOP Publishing.

Lee, H. H., Ahn, J. H., Kwon, A. R., Lee, E. S., Kwak, J. H., & Min, Y. H. (2014). Chemical composition and antimicrobial activity of the essential oil of apricot seed. *Phytotherapy research*, *28*(12), 1867-1872.

Lee, J., Durst, R. O. B. E. R. T., & Wrolstad, R. O. N. A. L. D. (2005). AOAC official method 2005.02: total monomeric anthocyanin pigment content of fruit juices, beverages, natural colorants, and wines by the pH differential method. *Official methods of analysis of AOAC International*, *2*.

Liu, M. J., & Zhang, Q. A. (2022). Valorization of the under-utilized apricot kernels protein based on the rheology and texture properties of dough. *LWT*, *169*, 114019.

Mohamed, A. A., Rayas-Duarte, P. A. T. R. I. C. I. A., Shogren, R. L., & Sessa, D. J. (2006). Low carbohydrates bread: Formulation, processing and sensory quality. *Food chemistry*, *99*(4), 686-692.

Montgomery, D. C. (2017). Design and analysis of experiments. John wiley & sons.

Mostafa, S. E., & Aly, A. M. (2014). Utilization of Apricot kernels. *Journal of Home Economics*, *24*(1).

Nkhata, S. G. (2020). Total color change (ΔE∗) is a poor estimator of total carotenoids lost during post-harvest storage of biofortified maize grains. *Heliyon*, *6*(10).

Nzikou, J. M., Kimbonguila, A., Matos, L., Loumouamou, B., Pambou-Tobi, N. P. G., Ndangui, C. B.,... & Desobry, S. (2010). Extraction and characteristics of seed kernel oil from mango (Mangifera indica). *Research Journal of Environmental and Earth Sciences*, *2*(1), 31-35.

Omer, H. A., Ahmed, S. M., Abedo, A. A., EL-Nomeary, Y. A., Nasr, S. M., & Nassar, S. A. (2020). Incorporation apricot seed kernel as untraditional source of protein in rabbit rations. *Bulletin of the National Research Centre*, *44*, 1-9.

Özboy-Özbaş, Ö., Seker, I. T., & Gökbulut, I. (2010). Effects of resistant starch, apricot kernel flour, and fiber-rich fruit powders on low-fat cookie quality. *Food Science and Biotechnology*, *19*, 979-986.

Ozturk, F., Gul, M., Ates, B., Ozturk, I. C., Cetin, A., Vardi, N.,... & Yilmaz, I. (2009). Protective effect of apricot (Prunus armeniaca L.) on hepatic steatosis and damage induced by carbon tetrachloride in Wistar rats. *British Journal of Nutrition*, *102*(12), 1767-1775.

Ross, M. A. (1994). Determination of ascorbic acid and uric acid in plasma by high-performance liquid chromatography. *Journal of Chromatography B: Biomedical Sciences and Applications*, *657*(1), 197-200.

Rudzińska, M., Górnaś, P., Raczyk, M., & Soliven, A. (2017). Sterols and squalene in apricot (Prunus armeniaca L.) kernel oils:

the variety as a key factor. *Natural product research*, *31*(1), 84-88.

Ruiz, D., Egea, J., Gil, M. I., & Tomás-Barberán, F. A. (2005). Characterization and quantitation of phenolic compounds in new apricot (Prunus armeniaca L.) varieties. Journal of Agricultural and Food Chemistry, 53(24), 9544-9552.

Sahingil, D., & Hayaloglu, A. A. (2021). Rheological and physicochemical properties of apricot kernel cream—An innovative cream-like product. *Journal of Food Processing and Preservation*, *45*(12), e16056.

Seerangurayar, T., Al-Ismaili, A. M., Jeewantha, L. J., & Al-Habsi, N. A. (2019). Effect of solar drying methods on color kinetics and texture of dates. *Food and Bioproducts Processing*, *116*, 227-239.

Shakir, I., Durrani, Y., Hussain, I., Qazi, I. M., & Zeb, A. (2007). Physicochemical analysis of apple and pear mixed fruit jam prepared from varieties grown in Azad Jammu and Kashmir. *International Journal of Food Safety*, *9*, 22-24.

Sheet, B. S. (2022). Effect of stevia substitution on physical, chemical and sensory properties of low-calorie apricot jam. *Texas Journal of Agriculture and Biological Sciences*, *2*, 31-41.

Tanwar, B., Modgil, R., & Goyal, A. (2018). Antinutritional factors and hypocholesterolemic effect of wild apricot kernel (Prunus armeniaca L.) as affected by detoxification. *Food & function*, *9*(4), 2121-2135.

Tanwar, B., Modgil, R., & Goyal, A. (2019). Effect of detoxification on biological quality of wild apricot (Prunus armeniaca L.) kernel. *Journal of the Science of Food and Agriculture*, *99*(2), 517-528.

Touati, N., Tarazona-Díaz, M. P., Aguayo, E., & Louaileche, H. (2014). Effect of storage time and temperature on the physicochemical and sensory characteristics of commercial apricot jam. *Food chemistry*, *145*, 23-27.

Vardi, N., Parlakpinar, H., Ozturk, F., Ates, B., Gul, M., Cetin, A.,... & Otlu, A. (2008). Potent protective effect of apricot and β-carotene on methotrexate-induced intestinal oxidative damage in rats. *Food and chemical toxicology*, *46*(9), 3015-3022.

Yada, S., Lapsley, K., & Huang, G. (2011). A review of composition studies of cultivated almonds: Macronutrients and micronutrients. *Journal of Food Composition and Analysis*, *24*(4-5), 469-480.

Zhang, Q. A., Wei, C. X., Fan, X. H., & Shi, F. F. (2018). Chemical compositions and antioxidant capacity of by-products generated during the apricot kernels processing. *CyTA-Journal of Food*, *16*(1), 422-428.

Zhou, C., Qian, L., Ma, H., Yu, X., Zhang, Y., Qu, W.,... & Xia, W. (2012). Enhancement of amygdalin activated with β-D-glucosidase on HepG2 cells proliferation and apoptosis. *Carbohydrate polymers*, *90*(1), 516-523.