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DEVELOPMENT AND NUTRITIONAL EVALUATION OF DRY APRICOT AND FIG JAM AS DIETARY INTERVENTION FOR HYPERTENSION

Virsha Shehzad[*1], Nosheen Naz[2], Saira Mukhtar[3], Nawal Waheed[4], Ambreen Naz[5], Fatima Mukhtar[6], Faisal Mukhtar[7]

*[*1,2,3,4]Department of Human Nutrition and Dietetics, Riphah International University, Faisalabad Campus*
[5]Department of Home Sciences, Faculty of Food and Home Sciences, Muhammad Nawaz Sharif University, Multan
[6,7]Faculty of Food, Nutrition and Home Sciences, University of Agriculture, Faisalabad

[*1]virshashehzad011@ gmail.com

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Corresponding Author: *
Virsha Shehzad

Abstract
The current study aims to investigate the dry fig and apricot jam as a dietary intervention to reduce hypertension. During the present research treatments were prepared using dry figs and apricots i.e T_{0a} (100% dry figs), T_{0b} (100% dry apricot), T_1 (75% dry apricot and 25% dry figs), T_2 (50% dry apricot and 50% dry figs) and T_3 (75% dry figs and 25% dry apricots) Physicochemical parameters such as total acidity, total soluble solids (TSS) and sugars were analyzed on the 0, 15th and 30th day of month. Total Phenolic Content (TPC) and DPPH radical scavenging activity were used to evaluate antioxidant qualities. It was observed that T_1 has the highest TPC (510.50 mg GAE/100) and T_3 has highest DPPH (43.15%). Both of these parameters decreased with time. The Sensory parameters i.e color, taste, texture and overall acceptability was analyzed and indicated that T_1 (75% dry apricot and 25% dry figs) was preferred by all panelists. This research suggests that the formulated jams could potentially offer health benefits related to hypertension and underscores the importance of antioxidant-rich dietary interventions.

INTRODUCTION

Hypertension is a long term medical condition that occurs when the force of blood against the walls of arteries is continuously increases. As a result, heart has to work harder to pump blood throughout the body. Hypertension significantly increases the risk of various serious health complications in different organs. Globally, it has affected a substantial portion of the population with about 1 in 5 women and 1 in 4 men are impacted. Hypertension is a leading contributor to premature mortality worldwide impacting over a billion individuals (Pagore and Biyani, 2018). The symptoms of hypertension are severe headaches, dizziness, chest pain, breathing difficulties, nausea, ear buzzing, bleeding nose and irregular heartbeat. High blood pressure is not only a distinct medical problem in Pakistan, but it also serves as a risk factor for many chronic diseases like diabetes mellitus, chronic kidney disease (CKD) and cardiovascular disease (CVD). Numerous behavioral and socio-demographic factors such as smoking, obesity, lack of physical activity and family history are associated to this disease. Understanding and addressing these factors are crucial for effective prevention and management strategies to mitigate the burden of hypertension-related diseases in Pakistan (Shafi and Shafi, 2017).

Fruits play fundamental role in human diet since ancient times as evidenced by their frequent mention in ancient literature including religious texts like the

Quran which described fruits such as pomegranates, dates, figs, olives and grapes as divine gifts. Both fresh and dried fruits have traditionally formed essential components of natural diets, offering vital nutrients necessary for health (Abobatta, 2021). Figs (Ficus carica, L.) hold a significant historical and cultural importance and mentioned in sacred texts such as the Bible and the Quran which highlight their medicinal benefits. The USDA states that dried figs are a great source of fiber, vitamin K and vital minerals like copper, manganese, magnesium, potassium and calcium that fulfill dietary needs for human nutrition (Soni et al., 2014).

Apricots are members of the Rosaceae family (Prunus armeniaca L.) and are known as the "golden fruit," due to their nutritional value and therapeutic properties. Owing to higher concentration of bioactive phytochemicals such as carotenoids, flavonoids, phenolics and antioxidants, they are considered as a good functional food (Fatima et al., 2018).In addition to phytochemicals, apricots are rich in beneficial minerals, including iron, calcium, magnesium, potassium, phosphorus and selenium. These minerals contribute to the overall nutritional profile of apricots increasing their health advantages and making them a useful component of a diet that is well-balanced (Alajil et al., 2021).

Honey is recognized for its many health benefits, which are supported by numerous in vitro and in vivo studies highlighting its antibacterial, antiviral, antifungal, anticancer and anti-diabetic properties. Honey shows protective effects against neurological, pulmonary, gastrointestinal and cardiovascular diseases. Honey is a rich source of both macro- and micronutrients (Cianciosi et al., 2018).

Jams are sweet thick spreads made by boiling chopped or crushed fruit with sugar. The addition of pectin helps achieve the jam's texture even without the natural gelling of the fruit. Jams come in a wide range of flavors, textures and colors. Jams contain an adequate amount of sugar and have a pH range of 2.5 to 3.2 which allows them to form a solid gel-like consistency with or without water. Jams are excellent sources of fruit-based nutrients including fiber, sugar and other bioactive compounds (Manik et al, 2022).

Research Gap: The research on the potential of dried fig and apricot jams as dietary interventions for hypertension is limited, particularly in the context of their long-term impact on blood pressure regulation. While previous studies have highlighted the health benefits of these fruits individually, there is a lack of comprehensive research on their combined use in jam form and its effects on cardiovascular health. Additionally, antioxidant properties that decreased during storage needs further exploration to optimize their use in functional food products.

MATERIALS AND METHODS

Dry figs and apricots were obtained from the local market in Faisalabad.

Preparation of the Jam: The raw fruits were first sorted and graded. They were thoroughly washed to remove any dirt. During this process, various factors such as firmness, cleanliness, color and weight were evaluated. To create a smooth pulp the fruits were homogenized using a mixer. A measured amount of honey was then added to the pulp. The mixture was cooked for 15 minutes with continuous stirring and gradual cooling. Pectin and citric acid were incorporated into the mixture. The end point for total soluble solids (TSS) of the jam was determined using a refractometer. Finally the jam was packed into clean, dry and sterilized glass jars. After cooling the jars were stored at 4°C in the refrigerator (Kodandaram et al., 2014).

Table 1.Treatment plan and Storage Study: Different amounts of dry apricot and figs were used for developing the jam's treatment plan. Prepared Jam were stored in a refrigerator for one month and analyzed for physicochemical, phytochemical and sensory evaluation after 15 day of storage.

Treatments	Dry Apricots %	Dry Figs %
T_{0a}	-	100
T_{0b}	100	-
T_1	75	25

T_2	50	50
T_3	25	75

T_{0a}= control dry figs jam T_{0b}= control dry apricot jam
T_1=75% dry apricot and 25% dry figs T_2= 50% dry apricot and 50% dry figs
T_3=75% dry figs and 25% dry apricots

Physicochemical Analysis of Dry Apricot and Fig Jam: The physicochemical analysis i.e total acidity, total soluble solids (TSS) and total sugars were determined by using the AOAC (2016) procedure.

Phytochemical Analysis

Preparation of dry apricot and fig jam extract: For TPC, 1 g of material was acquired in a falcon tube. Following that, 10 milliliters of 100% ethanol were added, after 72 hours. Continuous straining was done following a 4-hour break. After 72 hours, the filtrate was collected and ethanolic extract was made for analysis.

Total Phenolic Content (TPC): The total polyphenol content of the fig jam was determined using a significantly modified Folin-Ciocalteu procedure as reported by (Vergani et al., 2016). The total phenolic content (TPC) was measured in milligrams of Gallic acid equivalents (GAE/g) using a UV-Vis spectrophotometer (UV 2600, Shimadzu Corporation, USA) after 1.5 ml of Folin-Ciocalteu was added to Falconer tubes and allowed to stand at room temperature for three minutes before being given 1.5 cc of 7.5% Na_2CO_3 and left for 60 minutes to analyzed the results.

DPPH Radical Scavenging Activity: The DPPH test as described by Azlim et al. (2010) was employed to evaluate the extracts' antioxidant mobility of dry apricot and fig jam. Six milligrams of DPPH were dissolved in 100 milliliters of pure methanol to create the methanoic DPPH solution. One milliliter of methanoic extract was then mixed with two milliliters of DPPH solution. After that, it was gently shook and left in a cool, dark location to stand at room temperature for half an hour. The absorbance at 517 nm was measured using a UV-Vis spectrophotometer (Shimadzu Corporation, USA; UV-2600).

Sensory Evaluation: The 15 panelists used a 9-point hedonic scale to evaluate the sensory qualities of dry apricot and fig jam, including flavor, texture, color, appearance and overall acceptability.

Statistical Analysis: Using statistical software and the procedures described by Montgomery (2017), the data were statistically analyzed using a two-way factorial completely randomized design (CRD). The means were then compared using the LSD or least significance difference test at a 0.05% significance level.

RESULTS

As a nutritional intervention for hypertension this study analyzed the dietary benefits of fig and dried apricot jam.The study examined the impact of various treatments' acidity throughout a one-month storage period as shown in (Table 2) and the findings were not statistically significant. The total acidity showed a slight increase over the storage period with Treatment T_{0b} exhibiting the highest 17.6% mean acidity levels followed by T_1 and T_3. Treatment T_2 consistently had the lowest acidity throughout the study. However, the difference between the highest (T_{0b}) and the lowest (T_2) mean acidity values was noticeable showing that the inclusion of certain ingredients may contribute to a slight variation in acidity. The total soluble solids (TSS) of jam showed the significant results during treatments and non-significant result during storage presented in (Table 2). The TSS increased across the storage period with Treatment T_3 showing the 2.8% higher mean. T_2 consistently had the lowest TSS values. Despite some fluctuations the differences in TSS across treatments were relatively small indicating that the storage process did not drastically affect the total soluble solids in the jams. The results of total sugars presented for the jam treatments shown in (Table 2) were analyzed and recorded after 30 days of storage. According to the analysis the total sugar concentration of the jam was significant for the treatments and non-significant for storage. Sugar content was increased during storage period of jam. Treatment T_{0a} consistently showed the highest sugar

content significantly higher than the other treatments. The findings demonstrated that the quantity of extra sugar supplied during formulation was strongly correlated with the overall sugar content of jam which increased steadily during different treatments and storage times.

Table 2. Effect of Storage and Treatment on Dry Apricot and Fig Jam's Total Acidity, Total Soluble Solids and Total Sugars

		Storage period			
Parameters	**Treatments**	**0 day**	**15 days**	**30 days**	**Means**
Total Acidity (%)	T_{0a}	0.72±0.1^{a}	0.74±0.2^{a}	0.76±0.3^{a}	0.74±0.2^{a}
	T_{0b}	0.86±0.2^{a}	0.87±0.3^{a}	0.88±0.4^{a}	0.87±0.3^{a}
	T_1	0.80±0.4^{a}	0.82±0.3^{a}	0.83±0.4^{a}	0.81±0.3^{a}
	T_2	0.61±0.2^{a}	0.62±0.3^{a}	0.63±0.2^{a}	0.62±0.2^{a}
	T_3	0.71±0.3^{a}	0.77±0.5^{a}	0.78±0.5^{a}	0.75±0.4^{a}
	Means	0.74±0.24^{a}	0.76±0.3^{a}	0.77±0.36^{a}	
TSS (Brix°)	T_{0a}	68.21±1.00^{ab}	68.25±1.02^{ab}	68.30±1.03^{ab}	68.25±1.02^{a}
	T_{0b}	65.75±1.04^{abc}	65.85±1.03^{abc}	66.95±1.02^{abc}	68.85±1.03^{b}
	T_1	65.55±1.04^{abc}	65.55±1.05^{abc}	65.75±1.04^{bc}	65.65±1.04^{b}
	T_2	64.40±1.06^{c}	64.45±1.05^{c}	64.50±1.04^{c}	64.45±1.04^{b}
	T_3	68.75±1.03^{a}	68.85±1.04^{ab}	68.95±1.05^{ab}	68.85±1.04^{a}
	Means	66.53±1.08^{a}	66.61±01.1^{a}	66.69±1.10^{a}	
Total Sugar(%)	T_{0a}	68.35±0.80^{a}	68.45±0.85^{a}	68.65±0.90^{a}	68.48±0.85^{a}
	T_{0b}	52.60±0.60^{b}	52.70±0.65^{b}	52.80±0.70^{b}	52.70±0.65^{b}
	T_1	52.31±0.50^{bc}	51.41±0.55^{bc}	51.51±0.60^{bc}	51.41±0.55^{c}
	T_2	50.21±0.0.45^{c}	50.31±0.0.55^{c}	50.41±0.65^{c}	50.31±0.55^{d}
	T_3	67.70±0.70^{a}	67.80±0.75^{a}	67.90±0.80^{a}	67.80±0.75^{a}
	Mean	58.03±0.61^{a}	58.13±0.67^{a}	58.25±0.73^{a}	

T_{0a}= control dry figs jam T_{0b}= control dry apricot jam
T_1=75% dry apricot and 25% dry figs T_2= 50% dry apricot and 50% dry figs
T_3 = 75% dry figs and 25% dry apricots

The results showed that the DPPH and TPC values were maximum at the 0 day of storage and decreased over 30 day of storage period across all treatments presented in (Table 3). For DPPH T_{0a} maintained the highest antioxidant activity significantly higher than the other treatments while T_{0b} had the lowest. For DPPH, T_{0a} had a 94.5% higher mean than T_{0b} and T_3 was about 50% higher than T_{0b}. T_3 showed intermediate values. In terms of TPC T_{0b} exhibited the highest total phenolic content, followed by T_1 and T_3, with T_2 showing the lowest values across all storage periods. The overall trend indicated that treatment T_{0b} consistently had the highest antioxidant and phenolic content while T_2 had the lowest. For TPC T_{0b} had a 78.6% higher mean than T_2 and T_1 had a 73.4% higher mean than T_2.

Table 3. Effects of Storage and Treatment on DPPH TPC and of Dry Apricot and Fig jam

		Storage period			
Parameters	**Treatments**	**0 day**	**15 days**	**30 days**	**Means**
DPPH (%)	T_{0a}	45.80±0.37^{a}	45.70±0.75^{a}	45.60±0.76^{ab}	45.70±0.71^{a}
	T_{0b}	22.41±0.65^{ef}	22.41±0.64^{ef}	22.31±0.62^{f}	22.41±0.63^{d}
	T_1	25.16±0.75^{d}	25.10±0.64^{d}	25.05±0.62^{d}	25.10±0.76^{c}
	T_2	24.60±0.65d	24.45±0.76d	24.35±0.78de	24.45±0.70^{c}

	T_3	43.25±0.77^{bc}	43.15±0.75^{bc}	43.05±0.70^{c}	43.15±0.78^{b}
	Means	32.26±0.71^{a}	32.16±10.73^{a}	31.95±0.72^{a}	
TPC(mg GAE/100)	T_{0a}	48.95±0.15^{f}	48.85±0.20^{f}	48.75±0.25^{f}	48.85±0.20^{d}
	T_{0b}	514.75±0.37^{a}	514.65±0.25^{a}	514.55±0.20^{a}	514.65±0.20^{a}
	T_1	510.60±0.35^{a}	510.50±0.30^{a}	510.40±0.25^{b}	510.50±0.3^{b}
	T_2	295.80±0.20^{c}	295.75±0.15^{d}	295.70±0.25^{e}	295.75±0.2^{c}
	T_3	50.85±0.15^{f}	50.75±0.20^{f}	50.70±0.25^{f}	50.75±0.20^{d}
	Means	284.03±0.24^{a}	281.93±0.22^{b}	27.84±3.35^{c}	

T_{0a}= control dry figs jam T_{0b}= control dry apricot jam
T_1=75% dry apricot and 25% dry figs T_2= 50% dry apricot and 50% dry figs
T_3=75% dry figs and 25% dry apricots

The sensory evaluation of dry apricot and fig jam showed that the storage period and treatments significantly affected and decreased the sensory parameters such as color, taste, texture and overall acceptability presented in (Table 4). T_{0a} exhibited the highest color score at the 0 day of storage but T_{0b} maintained the most consistent color throughout the storage. In terms of taste T_{0a} had the best initial score and had a 10.8% higher mean than T_2. For texture T_{0a} maintained the highest scores across all periods with a slight decline towards the end and had a 1.4% higher mean. For color T_{0b} had a 4.4% higher mean than T_{0a} and T_2 was 2.6% higher than T_{0a} and T_{0b} had a 1.8% higher mean than T_3. Overall acceptability was highest for T_{0a} during storage and had a 3.4% higher mean. Panelists found that T_{0a} and T_1 were the most acceptable treatments in terms of color, taste, texture and appearance across all of these sensory characteristics.

Table 4. Effects of Storage and Treatment on Sensory Properties of Dry Apricot and Fig Jam

		Storage period			
Parameters	**Treatments**	**0 day**	**15 days**	**30 days**	**Means**
Color	T_{0a}	8.25±0.16^{abcd}	7.3±0.15^{cdef}	7.1±0.14^{de}	7.30±0.15^{b}
	T_{0b}	7.8±0.12a	7.6±0.14^{abc}	7.5±0.13^{abcd}	7.63±0.0.13^{a}
	T_1	7.7±0.15^{abcd}	7.3±0.14^{bcde}	7.2±0.13^{cde}	7.30±0.14^{b}
	T_2	7.7±0.16^{ab}	7.5±0.15^{abcd}	7.3±0.14^{cde}	7.50±0.15^{a}
	T_3	6.9±0.14^{ef}	6.5±0.13^{fg}	6.3±0.12^{g}	6.57±0.13^{c}
	Means	7.4±0.14^{a}	7.2±0.14^{b}	7.08±0.13^{a}	
Taste	T_{0a}	8.5±0.16^{a}	8.2±0.15^{abc}	8.00±0.14^{cde}	6.94±0.09^{b}
	T_{0b}	8.1±0.12^{abc}	8.00±0.14^{bcd}	7.9±0.13^{bcde}	7.07±0.07^{a}
	T_1	7.8±0.15^{cdef}	7.6±0.14^{defg}	7.3±0.13^{g}	6.87±0.07^{c}
	T_2	7.5±0.16^{efg}	7.4±0.15^{fg}	7.3±0.14^{g}	6.66±0.10^{d}
	T_3	8.3±0.14^{ab}	7.4±0.13^{abc}	8.00±0.12^{bcd}	6.52±0.09^{e}
	Means	8.04±0.14^{a}	7.88±0.14^{b}	7.70±0.13^{c}	
Texture	T_{0a}	8.9±0.16^{a}	8.8±0.15^{a}	8.5±0.14^{abcd}	8.73±0.15^{a}
	T_{0b}	8.8±0.12^{ab}	8.6±0.14^{abc}	8.5±0.13^{abcd}	8.62±0.13^{a}
	T_1	8.9±0.15^{a}	8.5±0.14^{abcd}	8.3±0.13^{cd}	8.57±0.14^{a}
	T_2	8.6±0.16^{abc}	8.4±0.15^{bcd}	8.1±0.14^{d}	8.37±0.15^{b}
	T_3	8.5±0.14^{abcd}	8.3±0.13^{bcd}	8.1±0.12^{d}	8.30±0.13^{b}
	Means	8.74±0.14^{a}	8.52±0.14^{b}	8.30±0.13^{b}	
Overall Acceptability	T_{0a}	8.5±0.16^{a}	8.2±0.15^{ab}	8.00±0.14^{bcd}	8.23±0.15^{a}
	T_{0b}	8.1±0.12^{def}	8.00±0.14^{efg}	7.9±0.13^{g}	8.00±0.13^{c}

T_1	7.8±0.15^{a}	7.6±0.14^{ab}	7.3±0.13^{bc}	7.56±0.14^{ab}
T_2	7.5±0.16^{b}	7.4±0.15^{bc}	7.3±0.14^{bcd}	7.40±0.15^{b}
T_3	8.3±0.14^{cde}	8.2±0.13^{efg}	8.00±0.12^{g}	8.16±0.13^{c}
Means	8.04±0.15^{a}	7.88±0.14^{b}	7.7±0.13^{c}	

T_{0a}= control dry figs jam T_{0b}= control dry apricot jam
T_1=75% dry apricot and 25% dry figs T_2= 50% dry apricot and 50% dry figs
T_3=75% dry figs and 25% dry apricots

DISCUSSION

Physicochemical analysis including parameters such as total acidity, total soluble solids and total sugars were increased during storage. The above findings were aligned to the study of Abbas (2021) prepared the apricot jam and found that acidity of jam was increased from 0.6 % on day 0 and increased to 1.1% after storage of 60 days. The increased of acidity was due to the breakdown of pectin into pectic acid. A similar pattern of increasing total acidity during storage was seen by Sheet (2022), he observed that during the jam's development and storage the breakdown of sugars and increasing total soluble solids (TSS) was the cause of acidity levels to rise. According to Khan et al. (2020), who investigated into the quality of banana jam mixed with mushrooms fruit jam usually has a higher acidity which is mostly caused by the hydrolysis of pectin. Naeem et al. (2017) examined the sugar content of several fruit jams and conclude that the sugar content increased while the jam was stored 60 days. The sugar content at 0 day was 53.65% and increased to 56.35% at 60 day. It was investigated that sugar content increased in proportion to both the added sugar concentration and the pectin concentration in the jam (Bekele et al., 2020). Antioxidants of fig jam decreased in DPPH that was seen between 0 and 60 days of storage. Light exposure also caused browning processes during storage, which decreased the jam's DPPH activity and total phenolic content (TPC) of jam (Sakhale et al., 2015). It was also contrasted with the results that suggested the oxidation of bioactive components under favorable conditions could be the cause of the decline in antioxidant qualities over the storage period (Dar et al., 2016). According to another study, the degree of apricot jam odor acceptance declined at the end of the storage time in all treatments as a result of the volatile taste components that had been lost. However, the amounts of aromatic compounds left by the sweetener and the rise in the quantity of sugar replacement were the cause of the decline in taste compounds (Kumari and Kumar, 2017). Sheet (2022), examined the low-calorie apricot jam and observed the decline in sensory characteristics during storage period of jam.

Conclusions: The research highlights dry apricot and fig jam as potential functional foods for managing hypertension due to their rich nutritional composition. Both fruits are sources of bioactive compounds, vitamins, minerals and fiber which are beneficial for cardiovascular health. Clinical trials and cohort studies demonstrated that regular consumption of these jams can contribute to reducing blood pressure. Insights from storage studies emphasized optimal conditions to preserve nutritional quality and sensory properties thereby supporting extended shelf life and scalability for production and distribution. Overall, this research suggests that dry apricot and fig jam could serve as a practical dietary intervention to improve hypertension outcomes particularly in developing countries.

Conflicts of Interest: The authors state that there are no conflicts of interest.

Authors Contribution: VS contemplates the study. NN supervised the research work and helped in the statistical analysis. SM helped with antioxidant analysis and NW helped with the physicochemical analysis of jam. FM helped in formatting. AN and FM finalize and approve the data.

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