FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 8 No. 5, October, 2024, pp 238 - 243
DOI: https://doi.org/10.33003/fjs-2024-0805-2839

PREPARATION AND NUTRITIONAL EVALUATION OF ENRICHED JAM MADE FROM BLENDS OF APPLE, STRAWBERRY AND GRAPES

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ABSTRACT

The aim of this study is to prepare an acceptable jam from blends of Apple, Strawberry and Grapes. Jams were produced from blends of Apple, Strawberry and Grapes in the following ratios 30:20:10:40 (A= 30g apple, 20g strawberry, 10g grapes and 40g of sugar) and 35:10:15:40 (B= 35g apple, 10g strawberry, 15g grapes and 40g of sugar) respectively. The pulp mixtures were combined with 40g of sugar. Mixed fruit jam and strawberry jam were used as commercial control labelled as sample C and D respectively. Standard methods were used for the determination of proximate composition, sugar content, phytochemical constituents and sensory evaluation of the Jam. The proximate composition indicated that sample A (15.31±0.12) and B (16.86±0.03) had a moisture content lower than the commercial control C (27.05±0.03) and D (27.60±0.45). The ash, fiber and lipid contents showed no significant difference in the jams produced and the commercial controls. Sample A and B had higher protein 29.58±0.02 and 27.41±0.01 as compared to the commercial controls C and D (24.62±0.02 and 25.15±0.01). No significant (P>0.05) difference was observed in the glucose composition of the sample A and B and the commercial controls C and D. Fructose content in sample A (2.74±0.21) was higher than sample B (1.94±0.01) and the commercial controls C (1.85±0.00) and D (1.42±0.00). Qualitative testing for flavonoids, terpenoids, cardiac glycoside and tannin revealed potential good health benefits. The sensory evaluation revealed that sample A which comprises of 30% apple, 20% strawberry, 10% grapes and 40% sugar was rated best in terms of color, odour, taste, aroma, texture and overall acceptability.

Keywords: Jam, Fruits, Proximate Composition, Sensory Evaluation

INTRODUCTION

Fruits are mother nature's one-of-a-kind medications, containing vitamins, minerals, antioxidants, and phytonutrients that aid in body upkeep, development, and disease resistance (Fernanda *et al*., 2022). They also come in a variety of flavors, scents, looks, and textures. Fruits are high in nutrients that are necessary for the body's daily maintenance; yet, they are only available while they are in season and can deteriorate quickly due to ripening (Leon, 2011). Jam is made by boiling fruit pulp with a suitable amount of sugar until it reaches a reasonably thick consistency. According to Anuar and Sallah (2019), the first fruit preserves were formed by combining the soft moist part of a fruit that had been mashed to a pulp with honey that had been sun-dried, resulting in a jam.

Jam is a shelf-stable food made of fruit pulp, pectin, and sugar that has been heated into a gel (Eliab, 2017). Fruits that are fleshy or pulpy, such as pineapple, pawpaw, strawberry, orange, Apple, banana, grapes and mango, as well as combinations of these fruits, are commonly used (Touati *et al.*, 2014). A good jam has a soft, uniform consistency with no discernible fruit pieces, a vivid color, a good fruit flavor, and a jam jellied texture that is simple to spread but has no loose liquid (Ho *et al.*, 2020). It's a product created by heating fruit pulp to a desired consistency. Because they have the highest levels of pectin and the best flavor, perfectly ripe and undamaged fruits are ideal for jam making. Low pectin fruits, such as strawberries, require additional pectin (from unripe lemon peel or pectin enriched sugar) to achieve a spreadable consistency (Adebayo and Abdus, 2019). Composite jam, which is made by combining two or more fruits to make jam, such as mango, pawpaw, pineapple, and so on, boosts the nutritional value of the final product while also adding variety to the morning menu. Although the production of composite jam necessitates careful handling and technological expertise, it is a beneficial and worthwhile venture in the long run (Akama *et al*., 2021).

Apple (*Malus Sylvestris*) is a species of the Rosaceae family and the pomoidae subfamily. Apples contain 84.7 % water, 13.9 g of carbs, 0.3 g of fats, 0.4 g of protein, and 8 mg of vitamin C per 100 grams of edible fruit. Apples are high in cell reinforcements such as flavonoids and polyphenols, which are typically found in the skin (Nafisah *et al.*, 2020). Apple has a strong healing capacity that aids in the treatment of a variety of infections, including diabetes, cardiovascular disease, joint inflammation, blockage, disease, ailment, loose bowels, Alzheimer's disease, and gallstones (Nafisah *et al.*, 2020).

Strawberry (*Fragaria x ananas Duch*.) fruits on the other hand, are widespread and widely consumed, both fresh and processed, and have a superb flavor and taste. The amount of ascorbic acid and secondary plant metabolites such as phenolic compounds present in strawberry fruits have been reported to have potential health benefits, which are linked to nutritional characteristics (Sebastian *et al*., 2014). Because of their fragile texture, high softening rate, and sensitivity to fungal assault and mechanical injury, strawberries have a short storage life (Fernanda *et al*., 2022). Processing is an alternative method for extending shelf life and availability in the off-season while also reducing post-harvest losses. Fruits that have been processed have less postharvest loss and provide more nutrients (Moshiur, 2018).

Grapes are an extremely valuable food and diet item. Grapes contain up to 30% easily digestible carbohydrates, including glucose, fructose, and a little of sucrose (Hussain and Abdrabba, 2015). Fresh grapes contain a wide range of organic acids (tartaric, malic, citric, succinic, oxalic, formic), as well as vitamins (A, B1, B2, B6, C), some minerals (such

as potassium, sodium, phosphorous, etc). Tartaric and malic acids gave the pleasant and agreeable taste of grapes. Grapes cause appetite, favor the breakdown of specific salts, and prevent the production of kidney stones by having a strong effect on the digestive organs (Utebaeva, 2020). Seedless (raisins) grape types are in high demand by the general public for fresh consumption, and they are also utilized in wine making in several countries (Utebaeva, 2020). The aim of this study is to prepare an acceptable jam from blends of apple, strawberry and grapes.

MATERIALS AND METHODS

Source of Material

Fresh, matured and healthy strawberries were purchased from shop opposite Oasis bakery in Maiduguri, Borno state. Apple and grapes were purchased from a fruit shop near Federal Government College (FGC), Maiduguri, Borno state. Sugar was obtained from Maiduguri Monday Market. The raw materials (fruits) were brought to the University of Maiduguri, Department of Biochemistry, Biochemistry laboratory in a corrugated soft board carton.

Sample Preparation

Sample of apple, (*malussylvestris)*, strawberry (*fragaria x ananassa*) and grape (*vitis vinifera*) were blended and the jam pulp were made from the sample. Each of the fruit was washed, dried and shield with a stainless steel knife into smaller pieces for blending. The fruits were blended using an electric blender (Binatone- BLG -555). The mixture of the fruit pulp was boiled for 15 minutes to soften the fruit piece in the pulp and pasteurized it. 43g of sugar was added after 15minute to the boiling fruit pulp with fragment stirring. After about 30 minutes of cooking, a gel was formed that is the pulp will drop from the spoon instead of pouring directly. The jam was poured directly into a sterilized bottle and allow to cool at a room temperature for further analysis.

Procedure for Making Mixed Fruit Jam

Mixed fruit jam was produced using the method described by Awolu, *et al.* (2018) which involved several stages as follows; Inspection to remove rotten or damaged fruits in other to avoid contaminating the functional jam to be produced. The selected fruits were washed with water containing 200 ppm of chlorine. Properties like pH and temperature were maintained. Water was not forced instead dump and spray washers were used to prevent fruits from getting damaged. The fruits were peeled with hand because of its small quantity. But for large manufacturing of jam, a machine with blades is to be used. Seeds and core part of the fruits were removed by pulping. There are various kind of machines available in the market for pulping different kind of fruits. These machines contain blades that can be adjusted to the needed size and quantity of material to be pulped. Sugar and pectin were added to the prepared fruit pulp in the required quantity using the suggestion of recipe development services. Water was added to lower the concentration. A network was formed as sugar was added because it freed up the pectin chains and bind the water molecules together. Harder jam is made by adding more pectin and sticky jam is made by adding more sugar says the recipe development consultants. Boiling is one of the most critical steps in jam making is which has to be done with more patience. The prepared mixture was kept on the flame. After a few minutes, the sugar started to dissolve and the room was filled with a fruity smell and a network like pectin. During the process, a foamy scum was seen forming over the layer and was skimmed with a spoon while the mixture was cooling and butter was added at this point to break the surface tension. The required amount of citric acid was added while boiling. To ensure proper setting of the jam, temperature of heating was maintained at 105℃. To check the background of the jam, sheet test was conducted. Sheet test was conducted by taking a small portion of jam and cooked, a little then it was allowed to drop from the spoon. If the jam drops or flakes the jam is prepared perfectly if not the jam is boiled for some more time. Bottles were sterilized before the hot jam was poured into it, the hot bottle was cooled by putting it into the water bath. Paraffin wax were used for waxing after which metal caps were vacuum capped to the bottle. Bottled jam was stored in a cool and dry place protected from direct sunlight before analysis.

Table 1: Formulation of Apple, Strawberry and Grape Fruits Jam (g/100g)

	Apple	Strawberry	Grapes	Sugar
Sample A	30	20	10	40
Sample B	35	10	15	40

Methods

Determination of Proximate Composition

Proximate analysis was carried out on the jams according to the methods of AOAC (2019) to determine their proximate composition i.e. their moisture, ash, crude protein, crude fat, crude fibre and carbohydrate content.

Dry Matter Content (AOAC 2019)

Daily matter content of the sample was determined by weighing log of sample into petri dish while placed in hot oven at l05ºC for 24 hours and then removed and placed in desiccators to cool after you reweigh.

The dry matter content was calculated using the formula:

$$\frac{W_l - W_2}{W_2 - W_2} \times 100$$

Where:

W = Weight of petri dish with sample in grams before oven dried.

W_2= Weight of petri dish with sample in grams after oven dried.

W_l= Weight in grams of empty petri dish

Phytochemical Analysis

Methodologies used for the determination of phytochemicals were adapted from those reported by Keay *et al*. (1964) and Ejikeme *at al*. (2014), to determine Anthraquinones, Terpenoids, Saponin Glycoside, Phlobatannins, and Tannins. Flavonoids and Alkaloids were determined as described by Sofowora (2008).

Test for Carbohydrates

Molisch's Test was used to confirm the presence of carbohydrates. To test for Monosaccharides, Braford's Test was used. Combined and Free Reducing Sugars were determined using Fehling's Test as described by Trease and Evans (1989). Soluble Starch, Pentoses and Ketones (Salivan Test) were determined by the method described by Vishnoi (1979). Cardiac Glycosides were also determined as described by Trease and Evans (1989).

Sensory Evaluation

Sensory evaluation of the different jam formulations was performed using the method described by Tsikritzi *et al.* (2014). Nine scales hedonic test was used to compare the degree of acceptability of the jams produced. The nine scales were denoted as '1' = dislike extremely, '2' = dislike very much, '3' = dislike moderately, '4' = dislike slightly, '5' = dislike, '6' = neither like or dislike, '7' = like slightly, '8'= like very much and '9'= like extremely. A total of 21 panelists consisting of students and staff from the department of Biochemistry, University of Maiduguri participated in the sensory evaluation. Each panelist received jam samples coded by three-digit random number to avoid bias and a glass of water to rinse the plate before or in the middle of the evaluation. Panelists were asked to evaluate the attributes including color, odor, taste, texture and overall acceptability of the given samples.

Data Analysis

All data collected were subjected to analysis of variance (ANOVA). All the determinations were made in triplicates and the differences among the means were separated using the DUNCAN multiple range test with significant differences at 5% ($p<0.05$).

RESULTS AND DISCUSSION

Proximate Composition

Table 2 presents the proximate composition of jams produced. The results showed a significant ($P<0.05$) difference in dry matter content between sample A and B, with sample A having the lower value. Samples C and D had the highest value. The results of the moisture content showed that sample A and B had the lowest values when compared to the commercial controls C and D.

The ash, lipid and fiber contents of the jam produced from sample A, B and commercial control samples C and D ranged from (3.26±0.24 to 3.87±0.00), (9.02±0.06 to 9.37±0.08) and (1.54±0.00 to 1.69±0.01) respectively.

There was a significant ($P<0.05$) difference in the protein content of the jams produced from sample A, B and the commercial control samples C and D. Results indicated that sample A had a higher protein content than sample B and the commercial controls sample C and D. However, both the jam produced were seen to have a higher protein than the commercial controls.

The carbohydrate (CHO) level of sample A and B were higher than the commercial controls sample C and D.

Table 2: Proximate Composition of Jam Produced from Blends of Apple, Strawberry and Grapes (%)

Sample	Dry Matter	Moisture	Ash	Lipid	Fiber	Protein	CHO
A.	41.69±0.01^{a}	15.31±0.12^{d}	3.87±0.00^{b}	9.02±0.06^{c}	1.58±0.01^{c}	29.58±0.02^{b}	42.64±0.08^{a}
B.	43.14±0.03^{b}	16.86±0.03^{c}	3.28±0.00^{a}	9.09±0.05^{ab}	1.63±0.00^{b}	27.41±0.01^{a}	38.93±0.03^{b}
C.	72.95±0.03^{c}	27.05±0.03^{b}	3.26±0.24^{d}	9.27±0.14^{c}	1.54±0.00^{d}	24.62±0.02^{d}	35.01±0.08^{c}
D.	72.40±0.05^{d}	27.60±0.45^{b}	3.65±0.01^{c}	9.37±0.08^{a}	1.69±0.01^{a}	25.15±0.01^{c}	32.54±0.04^{d}

Values are mean± SEM. Values with different superscript along the column are significantly different ($P< 0.05$)
Key: A= 30g apple, 20g strawberry, 10g grapes and 40g of sugar, B= 35g apple, 10g strawberry, 15g grapes and 40g of sugar, C= Commercial control 1(mixed fruit jam), D= Commercial control 2 (strawberry jam).

Sugar Composition

The result of the sugar composition of the samples A, B, C and D is presented in Table 3. No significant ($P> 0.05$) difference was observed in the glucose composition of the sample A and B and the commercial controls C and D. A significant difference was observed in the fructose composition of sample A and that of sample B and commercial controls, the fructose in A was above sample B and the commercial controls C and D. Results of the sucrose composition showed that there was no significant difference between sample A, B and commercial control D. The level of sucrose in commercial control C was found to be lower.

Table 3: Sugar Composition of Jam Produced from Blends of Apple, Strawberry and Grapes (g/100g)

Sample	Glucose	Fructose	Sucrose
A.	2.97±0.09^{a}	2.74±0.21^{a}	2.93±0.07^{a}
B.	2.97±0.03^{a}	1.94±0.01^{b}	2.41±0.03^{a}
C.	2.03±0.09^{a}	1.85±0.00^{b}	1.47±0.02^{d}
D.	2.96±0.03^{a}	1.42±0.00^{c}	2.69±0.02^{a}

Values are mean± SEM, Values with different superscript along the column are significantly different ($P< 0.05$)
Key: A= 30g apple, 20g strawberry, 10g grapes and 40g of sugar
B= 35g apple, 10g strawberry, 15g grapes and 40g of sugar
C= Commercial control 1(mixed fruit jam)
D= Commercial control 2 (strawberry jam)

Phytochemical Constituents

The Alkaloid test was negative for the samples A, B, C and D. The samples A, B, C and D tested positive and negative for flavonoids using the different methods used. Tannin also tested positive and negative for samples A, B, C and D using the respective methods used. Saponin tested negative for samples A, B, C and D using separate method and, samples A, B and C tested positive with different method while sample D tested negative. Samples A, B, C and D tested positive and also negative with the different methods employed for cardiac glycoside. The test for carbohydrate was positive for all samples using the different methods employed. The tests for phlobatannins, free and combined anthraquinone, phenolic and cardenolite proved negative for all the samples.

Table 4: Phytochemical Constituents of Jam Produced from Blends of Apple, Strawberry and Grape

S/no	Tests	Methods	Samples			
			Sample A	Sample B	Sample C	Sample D
1.	Test for Alkaloids	Dragendroff's reagent	-	-	-	-
		Mayer's reagent	-	-	-	-
2.	Test for Flavonoids	Shinoid's test	+	+	+	+
		Ferric chloride	-	-	-	-
		Lead acetate	+	+	+	+
		Sodium hydroxide	-	-	-	-
3.	Test for Tannin	Ferric chloride	-	-	-	-
		Lead acetate	+	+	+	+
4.	Test for Saponin		-	-	-	-
5.	Test for Terpenoid		+	+	+	-
6.	Test for Cardiac glycoside	Salkowski's test	+	+	+	+
		Lieberman Burcharide	-	-	-	-
7.	Test for Carbohydrate	Molisch test	+	+	+	+
		Test for monosaccharide (barfoed)	+	+	+	+
		Test for free reducing sugar (Fehling's test)	+	+	+	+
		Test for combined reducing sugar	+	+	+	+
		Test for ketoses	+	+	+	+
8.	Test for Phlobatannins		-	-	-	-
9.	Test for free anthraquinone		-	-	-	-
		Test for combined anthraquinone	-	-	-	-
10.	Test for phenolic		-	-	-	-
11.	Test for cardenolite	Keller killani	-	-	-	-

KEY: + =Positive
- =Negative

Sensory Evaluation

There was no significant difference in the color and odour of sample A, B and the commercial controls. Result showed that in terms of taste, sample A was superior to sample B and the commercial controls, however, there was no difference in taste value of sample B and commercial control C. The commercial controls had lower texture value than that of the jam produced from sample A and B. Sample A had the overall acceptability followed by sample B. The commercial controls were lower that the jam produced from sample A and B in terms of overall acceptability.

Table 5: Sensory Evaluation of Jam Produced from Blends of Apple, Strawberry and Grapes (%)

Sample	Color	Odor	Taste	Texture	Overall Acceptability
A.	8.71±0.17^{a}	7.86±0.030^{a}	8.52±0.30^{a}	8.76±0.23^{b}	9.43±0.15^{c}
B.	7.57±0.22^{a}	7.71±0.17^{a}	6.90±0.21^{b}	7.52±0.33^{a}	8.14±0.13^{b}
C.	7.67±0.27^{a}	6.52±0.19^{a}	6.62±0.23^{b}	5.14±0.30^{b}	7.43±0.27^{c}
D.	7.43±0.31^{a}	7.43±0.27^{a}	5.00±0.40^{c}	5.43±0.36^{b}	5.52±0.42^{b}

Values are mean± SEM. Values with different superscript along the column are significantly different (P< 0.05)
Key: A= 30g apple, 20g strawberry, 10g grapes and 40g of sugar, B= 35g apple, 10g strawberry, 15g grapes and 40g of sugar, C= Commercial control 1(mixed fruit jam), D= Commercial control 2 (strawberry jam).

Discussion

The dry matter observed in this study is above the dry matter for commercial jam apple reported by (Mendoza *et al.*, 2002). This implies that the jam obtained from this study is highly qualitative compared to the one reported by (Viktorija *et al.,* 2017).

The low moisture content observed in the test group samples is probably due to the processing method which involved

heating of the samples. This also implies that the jam produced in this study will have a longer shelf-life capacity to the commercially available ones because microorganism thrives in where there is a high moisture content. Similar work reported by Mendoza *et al.* (2002) showed that blend with a very low moisture content has a long shelf life.

The high level of ash contents observed in the test samples A and B is an indication that jam produced from apple, strawberry and grapes will have more mineral contents. The increase in the ash content might be as a result of inclusion of high proportion of grapes. The high percentage level of ash observed in the test samples was comparable to the commercial samples and this is an indication that these samples will have enriched mineral content compared to the commercially available jam. However, the percentage ash content observed in these samples were higher than those reported by (Eke-Ejiofor and Owuno 2013; Kansci *et al.* (2003) for pineapple and mango jam respectively.

The fat content of the samples competes favorably with the commercial controls jams. But when compared with those reported by (Food Standards Australia New Zealand, 2010) apple and strawberry were far above. This shows that the jams produced in this study is a rich source of fat. This agrees with earlier work of (Adebayo and Abdus, 2019).

The increase in fiber observed is due to the increase in the concentration of grape fruit which is a rich source of fiber. Therefore, the jam produced might be a remedy for reducing sugar absorption in individuals with Diabetics who are typically prescribed fiber-rich diets to reduce the glycemic reaction to food and, as a result, the requirement for insulin (Sofowara, 2008).

The protein content in the jam produced in this study implies that it is a good source of protein which is a body building food and was found to be consistent with reports by (Ullah *et al*., 2018). Also, it is higher than the protein content of pineapple and jackfruits jam produced by (Eke-Ejiofor and Owuno, 2013).

The carbohydrate level of all the jams shows that it is a good source of energy. It was reported that carbohydrate level ranged from 14 g/100 g to 48 g/100 g for apple, strawberry and grapes jams (USDA Database, 2022). High carbohydrate level in jams can be associated to the large presence of sugar. The low glucose concentration is probably due to the high strawberry content in the samples and it was reported by (FSANZ, 2010) that strawberry has low glucose content. The presence of sucrose may be attributed to the high amount of apple during jam-making. Sucrose helps in promoting pectin gelation during jam-making process (Bulone *et al.*, 2010). Sample B jams have the lowest fructose content but sample A have the highest. In comparison, the fructose content in strawberry fruits was reported to be much lower (Giampieri *et al*., 2012). The fructose content obtained for sample A was also similar to that previously reported (Touati *et al.*, 2014).

Flavonoids was present in all the samples which has a medical important such as anticancer, anti-inflammation and antiviral (Asad *et al*., 2020). The presence of Terpenoids in the samples indicates that the jam can help with antimicrobial, antifungal activity and will enhance memory (Deepak *et al.*, 2021). Cardiac glycoside is also present which has medical properties for heart failure and irregular heart beat (Usman, 2017). The presence of carbohydrate serves as energy in the jams produced, this is similar to the findings of (Jillian *et al.*, 2020).

In terms of color and odour, the samples proved to be appealing which is as a result of the high strawberry concentration and it is proven that strawberry has an appealing colour and smell. Similar results were observed in the study of (Moshiur, 2018). The taste of the samples is as a result of inclusion of grapes which has a quality of sweet taste. Result of the texture indicates that the jam from apple, strawberry and grapes blends which was neither too hard nor soft to spread were acceptable to the panelist. These results are in agreement with those previously reported by (Ho *et al*., 2020). This reveals that the jam produced from sample A was higher in terms of overall acceptability and was most preferred.

CONCLUSION

This study demonstrated the potential use of apple strawberry and grapes fruit in jam production. The findings from this study revealed that apple, strawberry and grapes could be used in the preparation of quality jam. Prepared jam from sample A (30g apple: 20g strawberry: 10g grapes: and 40g of sugar) was most preferred in terms of chemical composition, sugar composition and sensory evaluation. The product serves as good source of nutritional benefits, processing apple strawberry grape blends into jam will help in reducing the post-harvest loses of fruit and also reveal the utilization potential of underutilized fruit it also encourages the preservation of this fruit due to the seasonality which make them abundantly available during it season and uncommon during off season.

RECOMMENDATION

It is recommended that studies on the amino acid constituents, mineral elements and antimicrobial analysis should be carried out.

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