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Sensory Evaluation of Syneresis Reduced Jam and Marmalade Containing Gum Arabic from *Acacia senegal* var. *kerensis*

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Abstract

Jams and marmalades are some of the most popular food products because of their low cost, all year long availability and appealing sensory properties. These products are described as gels with pectin as the gelling agent used in its formulation. Gels are a form of matter intermediate between a solid and a liquid. They consist of polymeric molecules cross-linked to form tangles, and interconnected molecular network immersed in a liquid medium. However, the jams and marmalades require stabilization by hydrocolloids. The most common hydrocolloid stabilizer is pectin which is available as a low methoxy pectin or high methoxy pectin. Unfortunately, under mechanical stress, pectin gels may be damaged leading to the release of colloidal water. The release of the colloidal water is termed as syneresis. This problem may be solved by integrating pectin with other stabilizers having thickening properties. Jams were prepared using plums and pineapples while marmalades were prepared from oranges and lemons. Gum Arabic from *Acacia senegal* var. *kerensis* was added in the range of 1% - 5% which fell within the additives category. The prepared jams and marmalades underwent sensory evaluation using semi-trained panelists. The prepared jams and marmalades showed no evidence of syneresis. The jams and marmalades were subjected to a sensory panel who scored the different attributes against a 7-point hedonic scale. Gum Arabic at different levels was found to have a significant contribution to the consumer acceptance of the fruit spreads prepared. This is the first time that syneresis reduced jams and marmalades containing gum Arabic from *Acacia senegal* var. *kerensis* are being reported. Sensory evaluation was carried out on different fruit spreads used in the study to assess the impact of gum Arabic from *Acacia senegal* var. *Kerensis*. The parameters include taste,

texture, spreadability, aroma, flavour, colour and general acceptability. Red plum jam and Pineapple jam had its best performance for general acceptability use at 5% level of gum Arabic whereas 4% gum Arabic level performed best for general acceptability for Orange marmalade and 5% level best for Lemon marmalade in terms of general acceptability.

Keywords

Gum Arabic, Syneresis, Jam, Marmalade

1. Introduction

Jam and jelly products are prepared with a high concentration of dissolved solids forming gels. The formation of a gel is contributed to by the equilibrium in the "pectin-acid-sugar" system. Thus, commercial jam manufacture is based upon proper use of pectin and formation of pectin-sugar-acid gel [1]. Gels are a form of matter intermediate between a solid and a liquid. They consist of polymeric molecules cross-linked to form a tangled, interconnected molecular network immersed in a liquid medium [2]. The water as a solvent influences the nature and magnitude of the intermolecular forces that maintain the integrity of the polymer network. The polymers hold the water, preventing it from flowing in the acid medium. Pectin with sugar affects the pectin water equilibrium by forming a network of fibers throughout the gel [1]. The jams and marmalades in the Kenyan market suffer from high levels of syneresis. The term syneresis was invented by Graham in 1864 [3] to describe the undesirable phenomenon where liquid is expelled from a gel. Syneresis marks the upper limit of the liquid holding capacity of foods and determines the maximal water activity for which the sorption isotherms of foods are valid. The liquid expelled when syneresis occurs in a polymer-water system is pure water. However, in food systems such as jam, the internal solvent is a solution of sugars, salts and soluble polymers. The liquid that is observed in syneresis contains the same solutes as those inside the gel [3]. In this study, gum Arabic from *Acacia senegal* var. *kerensis* was used together with pectin to help curb syneresis. The interaction between the co-solutes and the polymeric matrix was assessed on the different jams and marmalades prepared. The jams and marmalades contained added gum Arabic from *Acacia senegal* var. *kerensis.*

2. Materials and Methods

2.1. Materials

Fresh mature fruits were procured from the local municipal market in Nakuru, Kenya. Citric acid, sodium bicarbonate and high methoxyl pectin were procured from Pradip Enterprises and Promaco Limited, Nairobi, Kenya. Gum Arabic was procured from Kennect Enterprises Limited.

2.2. Jam Preparation

The work was done at Egerton University, Department of Dairy, Food Science and Technology, Guildford Institute. Jam was prepared from red plums and pineapples while marmalade was prepared from oranges and lemons. The fruits were then washed thoroughly with water to containing 1% chlorine and rinsed [1]. They were then peeled, weighed and cut into small pieces using sharp stainless steel knives and blended to make the puree. The puree was weighed using a weighing balance, transferred to a heating pan and heated to soften any pieces remaining. Sugar was then added to the fruit pulp at the ratio of 55:45 parts respectively. The pH was checked using a pH meter (HANNA, 211; USA) and adjusted to pH 3.2 using citric acid or sodium bicarbonate. The mixture was let to cook to a ˚Brix of 72˚ before which pectin was added at the rate of 1%w/w in solution form to prevent clumping. Adding pectin in solution form lowers the brix to around 63˚ [4]. Different proportions of gum Arabic (1.0%, 2.0%, 3.0%, 4.0% and 5.0% on w/w basis) were added to the product. Boiling was continued while stirring until the desired ˚Brix reached 68˚. The end point was determined using a refractometer that indicated the ˚Brix achieved thus turning off the heat. Hot filling was done in sterile glass jars and covered with sterilized caps. The filled jars were cooled using cold water. A control jam was prepared with all the ingredients except gum Arabic. The formulated control jam served as a comparison between the jam containing gum Arabic versus the fruit spreads in the market.

2.3. Marmalade Preparation

For the preparation of marmalades (orange or lemon), the fruit peels were cut into small pieces after pulping. The size reduced peels were added to the fruit pulp during boiling. This is different from the preparation of fruit jams since the peels of fruits are not used. The ready marmalade was filled into clean, dry and sterilised glass containers while hot, sealed with lids and inverted to sterilise the lids. After 2 minutes in the inverted position, the containers were cooled gradually by immersion in water.

2.4. Sensory Evaluation

Sensory evaluation was undertaken at the Guildford Institute sensory evaluation room at Egerton University, Department of Dairy & Food Science and Technology. An in-house panel of 30 semi-trained panellists was used for the study. A 7-point hedonic scale was used to rate different attributes of the jams and marmalades prepared. Acceptance testing was used to determine how much each sample was liked based on the 7-point hedonic scale for a set of attributes vis-a-vis: general acceptability, colour, flavour, texture, aroma, spreadability and taste. The scale was interpreted where 7 = like extremely, 6 = like moderately, 5 = like slightly, 4 = neither like nor dislike, 3 = dislike slightly, 2 = dislike moderately, 1 = dislike extremely. The panellists evaluated the samples in individual

testing booths under white lighting where each panellist entered their sensory information.

2.5. Statistical Analysis

The experiment employed a completely randomized design (CRD) in a factorial arrangement. The first factor was the type of fruit while the second factor was the levels of gum Arabic (0%, 1%, 2%, 3%, 4% and 5%).

Data obtained from the quantitative descriptive analysis was analysed using the Statistical Analysis System (SAS, 2006) software, Version 9.1. The study hypotheses were tested by performing analysis of variance (ANOVA). Significance was established at $p < 0.05$ confidence level and mean separation was done using Tukey's Honestly Significant Difference (HSD) method.

3. Results and Discussion

3.1. Marmalade

The means and factorial effects of the various sensory attributes evaluated are shown in Table 1. The amount of gum Arabic added effect was significant at $p < 0.05$ for colour, and the type of fruit. The gum and interaction were significant for flavor and taste as shown in Table 1. The use of gum Arabic had a significant impact on the colour of the marmalade made. Patel & Goyal, (2015) reported that gum Arabic has unique properties such as being colourless and odourless thus, suitable for its use in the food industry [5]. The gum Arabic had no significant impact on the aroma of the marmalades.

The means for the different sensory attributes versus the fruits used in marmalade production are presented in Table 2. Lemon marmalade scored best for

Table 1. Mean square table for the main factor and factorial effect for different dependent variables of the marmalade.

S.O.V	DoF	Colour	Flavour	Aroma	Texture	Taste	Spreadability	General
Fruit	1	0.63^{ns}	61.67***	3.21*	0.18^{ns}	47.67***	0.00^{ns}	0.28^{ns}
Gum	5	0.92*	2.68***	1.55^{ns}	7.35***	2.71*	14.42***	5.87***
Fruit*gum	5	0.62^{ns}	3.10***	0.63^{ns}	1.17^{ns}	2.30*	2.44**	4.86***
Reps	29	3.58***	4.92***	13.41***	10.87***	6.61***	6.20***	5.11***
Error	319	0.40***	0.66***	0.76***	1.34***	0.95	0.78***	0.67***
CV	-	**10.54**	**14.24**	**16.18**	**21.33**	**17.57**	**15.53**	**14.37**
MSD	-	**0.13**	**0.17**	**0.18**	**0.20**	**0.18**	**0.18**	**0.17**

Key: S.O.V = Source of variation; DoF = Degree of freedom; Reps = Replicates; * = significant at $p < 0.05$ and *** = Significant at $p < 0.001$; ns = Not significant.

Table 2. Mean ± stderr for different sensory attributes as affected by the different fruits used in marmalade production.

Fruit	Colour	Flavour	Aroma	Texture	Taste	Spreadability	General
Lemon	$6.03^{a} \pm 0.06$	$5.28^{b} \pm 0.09$	$5.49^{a} \pm 0.10$	$5.41^{a} \pm 0.11$	$5.19^{b} \pm 0.09$	$5.68^{a} \pm 0.09$	$5.65^{a} \pm 0.08$
Orange	$5.94^{a} \pm 0.06$	$6.11^{a} \pm 0.06$	$5.31^{b} \pm 0.10$	$5.46^{a} \pm 0.11$	$5.92^{a} \pm 0.09$	$5.68^{a} \pm 0.09$	$5.71^{a} \pm 0.08$

Key: Means with the same letters are not significantly different at $p < 0.05$.

aroma (5.41) while orange marmalade scored best for flavor (6.11) and taste (5.92). There was no significant difference between the fruit type used to make marmalade in terms of colour, texture, spreadability and the general acceptability. Lemon marmalade was preferred by the panelists as it scored best for aroma while orange marmalade scored higher for flavor and taste. Orange marmalade is not new in the Kenyan market. Lemon marmalade however, is rare in the Kenyan market. Lemon has a more harsh taste as compared to oranges. The pH of the fruits was also different whereby lemon fruit has a lower pH and thus required Sodium Bicabornate to adjust the pH of the marmalade to a suitable range for gelling; pH 2.8 - 3.0. The pH of orange was found to be higher than the suitable range of pH 2.8 - 3.2 for making a stable gel for marmalades. The orange marmalade pH was using citric acid to lower the pH to suitable levels. There were no significant differences between the fruit type used to make marmalade in terms of colour, texture as well as spreadability. This can be attributed to the fact that both lemon and oranges are citrus fruits thus the marmalades from the fruits would be similar based on those attributes. The general acceptability of the orange and lemon marmalade was also quite similar as indicated in **Table 2**.

The effect of different levels of gum Arabic used on the attributes of the marmalade prepared from oranges and lemons is presented in **Table 3**. There was no significant difference in the level of gum Arabic used on colour and aroma. This is similar to findings by Mugo, (2012) where gum Arabic from *Acacia senegal* var. *kerensis* was used on low fat yogurt [6]. Similar results were also reported by Madhav *et al.*, (2007) where gum Arabic did not have any effect on the taste and appearance of the beverage prepared [7]. The marmalades containing 1 and 2% gum Arabic scored best in terms of flavor. Marmalades containing 2 and 3% had the best scores for texture with 2% gum Arabic scoring best in terms of spreadability. However, the marmalades without any gum Arabic scored least in terms of the general acceptability. In a study by Mugo, (2012) where gum Arabic was used as a water binder in low fat skim yogurt, similar results were reported where the control skim yogurt had the lowest values in all aspects except appearance and taste [6]. From the same study, it was found that the addition of gum Arabic to skim milk yogurt improved the texture and body of the yogurt as

Table 3. Means ± std error for the different sensory attributes due to the effect of different levels of gum Arabic.

Gum level	Colour	Flavour	Aroma	Texture	Taste	Spreadability	General
0%	$5.80^{a} \pm 0.10$	$5.35^{b} \pm 0.16$	$5.20^{a} \pm 0.21$	$4.83^{b} \pm 0.22$	$5.55^{ab} \pm 0.18$	$4.75^{c} \pm 0.12$	$5.12^{b} \pm 0.15$
1%	$5.87^{a} \pm 0.10$	$5.83^{a} \pm 0.15$	$5.43^{a} \pm 0.19$	$5.27^{ab} \pm 0.22$	$5.22^{b} \pm 0.18$	$5.78^{ab} \pm 0.15$	$5.68^{a} \pm 0.12$
2%	$6.05^{a} \pm 0.11$	$5.97^{a} \pm 0.14$	$5.28^{a} \pm 0.16$	$5.55^{a} \pm 0.19$	$5.53^{ab} \pm 0.15$	$6.10^{a} \pm 0.12$	$5.87^{a} \pm 0.15$
3%	$6.03^{a} \pm 0.11$	$5.67^{ab} \pm 0.15$	$5.32^{a} \pm 0.18$	$5.55^{a} \pm 0.17$	$5.50^{ab} \pm 0.14$	$5.60^{b} \pm 0.15$	$5.55^{a} \pm 0.14$
4%	$6.05^{a} \pm 0.11$	$5.73^{ab} \pm 0.14$	$5.57^{a} \pm 0.15$	$5.53^{a} \pm 0.17$	$5.85^{a} \pm 0.14$	$5.82^{ab} \pm 0.16$	$5.92^{a} \pm 0.12$
5%	$6.12^{a} \pm 0.10$	$5.60^{ab} \pm 0.12$	$5.60^{a} \pm 0.14$	$5.87^{b} \pm 0.14$	$5.70^{ab} \pm 0.17$	$6.03^{ab} \pm 0.14$	$5.93^{a} \pm 0.12$

Key: Means with the same letters are not significantly different at $p < 0.05$.

well as the acceptability rating. This was attributed to the high molecular weight and gelling properties of *Acacia senegal* var. *kerensis* gum leading to a better mouth feel. According to Mandhav *et al.*, (2007), the gel strength positively correlated with consumer acceptance of yogurt [7].

The means for the different sensory attributes evaluated versus the interactions between the different levels of gum Arabic and fruit types are given in **Table 4**. Lemon marmalade with 1% and 5% scored best for colour (6.23). Lemon marmalade with 5% gum Arabic scored best in terms of aroma and texture at 5.7 and 5.93, respectively. Orange marmalade containing 2% gum Arabic scored best in terms of flavor, taste and spreadability while the orange marmalade with 4% gum Arabic scored best in terms of general acceptability. The marmalades containing gum Arabic at the levels of 2% and 3% scored best for texture. It was also observed that the marmalades having level 2% gum Arabic scored best in the attribute of spreadability. Texture is a very important parameter for sensory acceptance [8] and depends largely on the composition of raw material such as the type of fruit, fruit quantity, and sugars used but also on the type of hydrocolloids used as indicated by Cropotova *et al.*, (2015) [9]. For the purpose of spreading jam on slices of bread, it should be noted that jams with a lower elastic phase are more difficult to spread. In the extreme case, this implies that jellies spread on bread slices with a knife will just break up from a large lump into many smaller pieces [8]. Gels with a higher viscous share will spread easily and form a coherent jelly layer on the bread. From this study, the increase in the concentration of gum Arabic led to an increase in the viscous share making it easier to spread.

Table 4. Means ± std error for the different sensory attributes due to the effect of interaction between different levels of gum Arabic and fruits.

Fruit	Gum	Colour	Flavour	Aroma	Texture	Taste	Spreadability	General
Lemon	0%	$5.80^{c} \pm 0.13$	$4.50^{f} \pm 0.18$	$5.27^{c} \pm 0.29$	$4.97^{d} \pm 0.35$	$5.23^{e} \pm 0.25$	$4.77^{e} \pm 0.18$	$5.53^{c} \pm 0.19$
	1%	$5.90^{c} \pm 0.15$	$5.50^{cd} \pm 0.25$	$5.53^{ab} \pm 0.27$	$5.37^{c} \pm 0.32$	$4.70^{g} \pm 0.22$	$5.63^{c} \pm 0.19$	$5.53^{c} \pm 0.19$
	2%	$5.97^{bc} \pm 0.18$	$5.67^{c} \pm 0.23$	$5.57^{ab} \pm 0.22$	$5.47^{c} \pm 0.25$	$4.93^{f} \pm 0.19$	$5.97^{b} \pm 0.17$	$5.60^{bc} \pm 0.23$
	3%	$6.23^{a} \pm 0.13$	$5.47^{d} \pm 0.25$	$5.30^{c} \pm 0.25$	$5.37^{c} \pm 0.28$	$5.17^{cd} \pm 0.17$	$5.93^{b} \pm 0.22$	$5.50^{c} \pm 0.24$
	4%	$6.03^{bc} \pm 0.14$	$5.37^{d} \pm 0.23$	$5.60^{ab} \pm 0.21$	$5.37^{c} \pm 0.19$	$5.47^{d} \pm 0.21$	$5.63^{c} \pm 0.24$	$5.60^{bc} \pm 0.18$
	5%	$6.23^{a} \pm 0.12$	$5.17^{e} \pm 0.14$	$5.70^{a} \pm 0.16$	$5.93^{a} \pm 0.21$	$5.67^{c} \pm 0.27$	$6.17^{ab} \pm 0.19$	$6.13^{ab} \pm 0.18$
Orange	0%	$5.80^{c} \pm 0.15$	$6.20^{b} \pm 0.13$	$5.13^{cd} \pm 0.32$	$4.70^{e} \pm 0.29$	$5.87^{b} \pm 0.26$	$4.73^{e} \pm 0.0.18$	$4.70^{d} \pm 0.21$
	1%	$5.83^{c} \pm 0.14$	$6.17^{ab} \pm 0.13$	$5.33^{bc} \pm 0.27$	$5.17^{cd} \pm 0.30$	$5.73^{bc} \pm 0.26$	$5.93^{b} \pm 0.24$	$5.83^{b} \pm 0.14$
	2%	$6.13^{ab} \pm 0.13$	$6.27^{a} \pm 0.15$	$5.00^{d} \pm 0.21$	$5.63^{bc} \pm 0.29$	$6.13^{a} \pm 0.16$	$6.23^{a} \pm 0.18$	$6.13^{ab} \pm 0.19$
	3%	$5.83^{c} \pm 0.17$	$5.87^{bc} \pm 0.16$	$5.33^{bc} \pm 0.25$	$5.73^{ab} \pm 0.21$	$5.83^{b} \pm 0.21$	$5.27^{d} \pm 0.19$	$5.60^{bc} \pm 0.15$
	4%	$6.07^{b} \pm 0.15$	$6.10^{ab} \pm 0.14$	$5.53^{bc} \pm 0.22$	$5.70^{b} \pm 0.28$	$6.23^{a} \pm 0.16$	$6.00^{b} \pm 0.22$	$6.23^{a} \pm 0.15$
	5%	$6.00^{bc} \pm 0.17$	$6.03^{b} \pm 0.15$	$5.50^{b} \pm 0.24$	$5.80^{ab} \pm 0.18$	$5.73^{bc} \pm 0.22$	$5.90^{b} \pm 0.22$	$5.73^{bc} \pm 0.14$

Key: Means with the same letters are not significantly different at $p < 0.05$.

3.2. Jam

The means and factorial effect for different dependent variables of jam products are shown in Table 5. It was observed that the effect of the type of fruit was highly significant on the flavor, aroma, taste, spreadability as well as general acceptability of the fruit jam. The level of gum used in the jam and the interaction of the gum and the fruit used to make the jam was highly significant on the spreadability of the jam at $p < 0.001$.

The means for the different sensory attributes due to the effect of different fruits are presented in Table 6. Red plum jam recorded better scores compared to pineapple jam in terms of the flavor, aroma, taste, spreadability and general acceptability.

The means for the different sensory attributes due to the effect of different levels of gum Arabic are presented in Table 7. The level of gum used had no significant

Table 5. Mean square table for the main factor and factorial effect for different dependent variables of jam products.

S.O.V	DoF	Colour	Flavour	Aroma	Texture	Taste	Spreadability	General
Fruit	1	1.06^{ns}	15.21***	6.53***	1.81^{ns}	8.87***	17.34***	0.56***
Gum	5	0.56^{ns}	0.81^{ns}	0.29^{ns}	1.70^{ns}	1.60*	9.56***	1.32^{ns}
Fruit*gum	5	0.30^{ns}	0.29^{ns}	0.43^{ns}	1.61^{ns}	1.15^{ns}	21.24***	0.57^{ns}
Reps	29	1.07***	2.96***	4.08***	3.91***	3.34***	2.12***	2.58^{ns}
Error	319	0.42***	0.70***	0.74***	0.84***	0.69***	0.84***	0.65***
CV	-	**10.31**	**14.00**	**14.91**	**16.35**	**14.02**	**15.56**	**13.44**
MSD	-	**0.13**	**0.17**	**0.18**	**0.19**	**0.17**	**0.19**	**0.17**

Key: S.O.V = Source of variation; DoF = Degree of freedom; Reps = Replicates, *CV* = Coefficient of variation, *MSD* = Minimum significance difference, * = Significant at $p < 0.05$ and *** = Significant at $p < 0.001$, ns = Not significant

Table 6. Means ± std error for the different sensory attributes due to the effect of different fruits.

Fruit	Colour	Flavour	Aroma	Texture	Taste	Spreadability	General
Pineapple	$6.20^{a} \pm 0.06$	$5.76^{b} \pm 0.08$	$5.65^{b} \pm 0.08$	$5.53^{a} \pm 0.08$	$5.78^{b} \pm 0.07$	$5.62^{b} \pm 0.10$	$5.83^{b} \pm 0.07$
Plums	$6.31^{a} \pm 0.04$	$6.17^{a} \pm 0.06$	$5.92^{a} \pm 0.07$	$5.67^{a} \pm 0.08$	$6.10^{a} \pm 0.07$	$6.06^{a} \pm 0.07$	$6.14^{a} \pm 0.06$

Key: Means with the same letters are not significantly different at $p < 0.05$.

Table 7. Means ± std error for the different sensory attributes due to the effect of different levels of gum Arabic.

Gum	Colour	Flavour	Aroma	Texture	Taste	Spreadability	General
0%	$6.31^{a} \pm 0.09$	$6.01^{a} \pm 0.13$	$5.83^{a} \pm 0.12$	$5.57^{ab} \pm 0.13$	$6.15^{a} \pm 0.11$	$5.97^{a} \pm 0.14$	$6.07^{a} \pm 0.12$
1%	$6.30^{a} \pm 0.08$	$5.98^{a} \pm 0.13$	$5.78^{a} \pm 0.13$	$5.30^{b} \pm 0.13$	$5.85^{a} \pm 0.13$	$5.10^{b} \pm 0.20$	$5.86^{a} \pm 0.11$
2%	$6.28^{a} \pm 0.09$	$5.77^{a} \pm 0.11$	$5.73^{a} \pm 0.14$	$5.62^{ab} \pm 0.14$	$5.80^{a} \pm 0.14$	$5.73^{a} \pm 0.13$	$5.85^{a} \pm 0.12$
3%	$6.28^{a} \pm 0.08$	$5.91^{a} \pm 0.11$	$5.77^{a} \pm 0.14$	$5.63^{ab} \pm 0.15$	$5.78^{a} \pm 0.13$	$6.14^{a} \pm 0.11$	$5.93^{a} \pm 0.13$
4%	$6.06^{a} \pm 0.09$	$6.03^{a} \pm 0.14$	$5.72^{a} \pm 0.13$	$5.67^{ab} \pm 0.14$	$5.93^{a} \pm 0.12$	$6.19^{a} \pm 0.12$	$5.97^{a} \pm 0.11$
5%	$6.29^{a} \pm 0.09$	$6.10^{a} \pm 0.11$	$5.91^{a} \pm 0.13$	$5.81^{a} \pm 0.13$	$6.14^{a} \pm 0.12$	$6.92^{a} \pm 0.15$	$6.25^{a} \pm 0.10$

Key: Means with the same letters are not significantly different at $p < 0.05$.

difference in terms of colour, flavor, and aroma of the jam. This is attributed to the properties of gum Arabic making it suitable for use in the food industry as it is odourless and colourless as indicated by Soibe *et al.*, (2015) [10]. However, the addition of gum Arabic at 5% level in jam scored best for texture, taste, spreadability and general acceptability. Gum Arabic has a similar effect on jam as in marmalades in terms of texture and spreadability. Higher concentration of gum Arabic was preferred among the panelists. It is observed that an increase in gum Arabic in the jam increases the viscous phase therefore making the jam easy to spread on the bread giving it a smoother texture. Other studies where the composition of jam has been altered by Awad & Shokry (2018), reported no significant differences in the general acceptability of pumpkin jam made by varying the composition of pumpkin jam with orange juice [11]. In a similar study by Shokry *et al.*, (2018) where pomegranate jam was prepared incorporating different spices and cloves indicated that there was no significant difference in the overall acceptability of the jams with spices [12].

The means for the different sensory attributes due to the effect of interaction between the different levels of gum Arabic and the type of fruit are presented in Table 8. The jam prepared with plums and containing a level of 5% gum Arabic was much liked for all the attributes evaluated followed by the 3% gum Arabic level. For the jam prepared from pineapples, a similar observation was made. That is, the jam containing a level of 5% gum Arabic was highly scored for all the key variables (Table 8).

4 Conclusion and Recommendations

The level of gum used in this study was between 1% and 5% which validates its

Table 8. Means ± std error for the different sensory attributes due to the effect of interaction different levels of gum Arabic and the fruit.

Fruit	Gum	Colour	Flavour	Aroma	Texture	Taste	Spreadability	General
Pineapple	0%	$6.13^{cd} \pm 0.13$	$5.72^{cd} \pm 0.20$	$5.65^{bc} \pm 0.18$	$5.53^{bc} \pm 0.19$	$6.03^{a} \pm 0.16$	$5.50^{e} \pm 0.22$	$5.95^{bc} \pm 0.20$
	1%	$6.30^{bc} \pm 0.13$	$5.80^{cd} \pm 0.21$	$5.63^{c} \pm 0.18$	$5.13^{d} \pm 0.16$	$5.57^{d} \pm 0.21$	$3.97^{g} \pm 0.20$	$5.58^{d} \pm 0.17$
	2%	$6.30^{bc} \pm 0.12$	$5.60^{d} \pm 0.14$	$5.73^{bc} \pm 0.19$	$5.67^{b} \pm 0.18$	$5.83^{c} \pm 0.20$	$5.60^{d} \pm 0.18$	$5.70^{cd} \pm 0.20$
	3%	$6.20^{c} \pm 0.15$	$5.65^{cd} \pm 0.16$	$5.57^{c} \pm 0.21$	$5.30^{cd} \pm 0.21$	$5.43^{d} \pm 0.16$	$5.82^{c} \pm 0.17$	$5.67^{cd} \pm 0.16$
	4%	$5.98^{d} \pm 0.15$	$5.81^{c} \pm 0.21$	$5.52^{c} \pm 0.18$	$5.81^{ab} \pm 0.19$	$5.81^{c} \pm 0.18$	$6.27^{b} \pm 0.18$	$5.87^{c} \pm 0.16$
	5%	$6.28^{bc} \pm 0.16$	$6.00^{b} \pm 0.18$	$5.83^{b} \pm 0.17$	$5.72^{b} \pm 0.19$	$6.03^{b} \pm 0.18$	$6.59^{a} \pm 0.21$	$6.22^{ab} \pm 0.15$
Plums	0%	$6.48^{a} \pm 0.10$	$6.30^{a} \pm 0.17$	$6.02^{a} \pm 0.16$	$5.60^{bc} \pm 0.19$	$6.27^{a} \pm 0.14$	$6.43^{ab} \pm 0.13$	$6.13^{ab} \pm 0.13$
	1%	$6.30^{bc} \pm 0.09$	$6.17^{a} \pm 0.15$	$5.92^{ab} \pm 0.18$	$5.47^{c} \pm 0.20$	$6.13^{ab} \pm 0.13$	$6.23^{b} \pm 0.16$	$6.13^{ab} \pm 0.13$
	2%	$6.27^{bc} \pm 0.14$	$5.93^{ab} \pm 0.17$	$5.72^{bc} \pm 0.20$	$5.57^{bc} \pm 0.22$	$5.77^{c} \pm 0.21$	$5.87^{c} \pm 0.19$	$6.00^{bc} \pm 0.13$
	3%	$6.35^{b} \pm 0.10$	$6.17^{a} \pm 0.13$	$5.97^{ab} \pm 0.17$	$5.95^{a} \pm 0.19$	$6.13^{ab} \pm 0.17$	$6.47^{ab} \pm 0.12$	$6.18^{ab} \pm 0.20$
	4%	$6.13^{cd} \pm 0.10$	$6.27^{a} \pm 0.17$	$5.93^{ab} \pm 0.19$	$5.53^{bc} \pm 0.20$	$6.05^{b} \pm 0.16$	$6.10^{b} \pm 0.18$	$6.07^{b} \pm 0.16$
	5%	$6.30^{bc} \pm 0.11$	$6.20^{a} \pm 0.14$	$5.98^{ab} \pm 0.20$	$5.90^{ab} \pm 0.17$	$6.23^{ab} \pm 0.18$	$5.27^{f} \pm 0.14$	$6.27^{a} \pm 0.14$

Key: Means with the same letters are not significantly different at $p < 0.05$.

use as a food additive. From the study, the most preferred level of gum arabic to be added in pineapple and red plum jam was 5%, as this was the best combination preferred by the panelists. In marmalades, 4% gum Arabic would be the recommended level for orange marmalade while 5% will be the recommended level for lemon marmalade based on the general acceptability of the products.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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