THE MINIMUM LEVEL OF PRESERVATIVES NEEDED TO PRESERVE JAMS, JELLIES AND MARMALADES UNDER GHANAIAN CONDITIONS

By

W.K.A. AMOA-AWUA

Food Research Institute
P.O. Box M.20,
Accra.

1977.

3. THE MINIMUM LEVEL OF PRESERVATIONS NEEDED TO PRESERVE JAMS, JELLIES AND MARMALADES UNDER GHANAIAN CONDITIONS

INTRODUCTION:

This project was intended to be completed in 10 months but was suspended after 3 months because of the introduction of the Food Research Institute Co-ordinated Research Programmes. As this project did not fit into the programmes it has not yet been continued.

The project was undertaken because at the 12th session of Codex Committee on Processed Fruits and Vegetables, delegates from several temperate countries thought that the level of preservatives used in jams and marmalades ought to be lowered. Some members even advocated the abolision of preservatives from these foods. It was at the insistence of delegates from tropical countries that the use of preservatives was retained. The Ghana delegation fought hard to retain the highest level of preservatives even though information on the minimum quantity needed to maintain the stability of these products under Ghanaian conditions was not available. This project was to investigate the minimum level of preservatives needed to maintain the stability of these processed fruits under Ghanaian conditions.

LITERATURE REVIEW:

The principle underlying the manufacture of jams, jellies and marmalades is the formation of gel. The main factors responsible for gel formation are pectin, sugar and acid. Gel formation occurs within a specific range of pH (2.7 to 3.4) the optimum being pH 3.0 and the best concerntration of sugar 67.5%. However it is possible to make jellies, with high content of pectin and acid, containing less than 60% sugar.

Any fruit can be used to make jams, jellies and marmalades. A jelly is the product prepared from the juice or aqueous extract of a fruit boiled with sugar and concentrated to such a consistency that gelatinization takes place when the product is cooled. A marmalade is a clear jelly in which are suspended slices of fruit or peel. Jam is a product prepared from a

whole fruit pulp boiled with sugar to a moderately thick consistency without retaining the shape of the fruit.

Pectin is the most important constituent in jelly making. Pectic substances exist in plants as pectose, pectin and pectic acid. They are those complex colloidal carbohydrate derivatives which contain a large proportion of anhydrogalacturonic acid derivatives which are thought to exist in chainlike combination. The carboxyl groups of the polygalacturonic acids may be partly esterified by methyl groups and partly or completely neutralized by one or more bases. Protopectin is the water-soluble parent pectic substance which upon restricted hydrolysis yields pectin or pectinic acids. Pectin designates those water-soluble pectinic acids of varying methyl ester content and degree of neutralization which are capable of forming gels with sugar and acid under suitable conditions. Pectin is formed either by the acid hydrolysis of protopectin or by the action of hydrolysing enzymes formed in tissues during ripening.

The amount of pectin necessary to form a gel depends on several factors including its quality and quantity, the nature of the recipe and the soluble solids content of the finished product. Some fruits do not require additional pectin to form a gel but with those fruits low in pectin, it is necessary to add commercial pectin to the ingredients in order to form a jelly of uniform consistency and to ensure that products are of uniform quality and appearance.

Jams, jellies and marmalades contain between 65% and 70% sugar. During boiling with acid, sucrose a non-reducing sugar is converted to 2 reducing sugars, glucose and fructose. The rate of inversion is influenced by the pH of the mixture, the boiling temperature and time. Invert sugar retards or prevents caramelization of sucrose in the product, so a balance should be maintained between sucrose and invert sugar. Low inversion results in caramelization of sucrose whilst high or complete inversion results in granulation of fructose. The optimum percentage of invert sugar is between 35% and 40% of the total sugar in the jam.

Food additives that my be added to jams, jellies and marmalades include Anti-Foaming Agents, Flavours, Firming Agents and Colouring matters.

After jam boiling, if the product is left without the addition of preservatives, it may or may not grow mouldy depending on its final composition. If the soluble solids content is 70% or higher, the food will be preserved because its water activity will not be sufficient to support microbial growth. Preservatives that are added to jams, jellies, and marmalades include sodium benzoate, sorbic acid, potassium sorbate and esters of parahydroxy benzoic acid.

EXPERIMENTAL

MATERIALS AND METHODS

1/ GEL FORMATION

Method:

Enough sugar was added to 0.5 kg of prepared fruit to raise the soluble solids content to 50%. About 200 mls of water were added to the preparation and boiled for about 30 mins. to cause intimate mixing of the fruit pulp and the sugar and to partially concentrate the product by evaporation of the excess moisture. A pectin solution was prepared by dissolving one part of amidated pectin in 8 parts of sugar in heated water. When the percentage of soluble solids in the boiling syrup had risen to 60%, enough pectin solution was added to the boiling mixture to make up 1% of the total weight. The boiling was stopped when the percentage of soluble solids in the boiling mixture measured with an Abbe Regractometer was 68.5%. Another method of determining the end point was by measuring the temperation of the boiling syrup. The temperature of the syrup at the jelling point is 104^{o}C which corresponds to 65-68% total solids in the jelly after cooling.

Immediately after boiling the pH of the jam was measured with a pH-meter and adjusted to pH 30 by the addition of citric acid. The jam was filled hot into pasteurized jars. The jam was allowed to cool and tested to see if it had formed a firm gel. The gel strength could not be measured as planned because the F.I.R.A. Jelly. Tester at the Food Science Department, University of Ghana had broken down.

The experiment was repeated using the same weights of ingredients except that no pectin was added. The two sets of experiments were carried out using the following fruits to determine which ones were able to form a gel without the addition of pectin.

i. orange
ii. pineapple
iii. pawpaw
iv. Guava
v carambola
vi. pawpaw and orange
vii. carambola and pineapple

2/ COMPARISON OF THE EFFECTIVENESS OF DIFFERENT PRESERVATIVES

Method:

0.5kg of prepared orange was added to 0.5kg of sugar dissolved in 200 ml of water and boiled for about 30 minutes. 1% pectin solution was added to the boiling syrup and the boiling stopped when the soluble solids content of the boiling syrup had risen to 68.5%. The pH of the jam was adjusted to 3.0 with citric acid. The jam was divided into 3 portions and 300 p.p.m. of the following different preservatives added to the different aliquots of jam; sorbic acid, sodium benzoate and potassium sorbate. The different portions were filled hot into different jars and periodically tested for mould growth.

3/. DIFFERENT LEVELS OF PRESERVATIVE

Method:

The soluble solids content of a 1kg sugar-fruit mixture was raised from 50% to 64% by boiling and enough pectin solution added to make up 1% of the total volume. The boiling was continued until the soluble solids content measured 68.5%. The pH of the jam was adjusted to 3.0 with citric acid. The jam was divided into several portions and different amounts of potassium sorbate added to the different portions. The samples were inspected at weekly intervals for mould growth.

RESULTS

a. Gel Formation

FRUIT	FORMED GEL IN ABSENCE OF ADDITIONAL PECTIN	DID NOT FORM GEL IN ABSENCE OF ADDITIONAL PECTIN
(1) Orange	-	Orange
(2) Pawpaw	pawpaw	-
(3) Pineapple	pineapple	very ripe apineapple
(4) Lemon	-	Lemon
(5) Guava	guava	very ripe guava
(6) Carambola	carambola	very ripe carambola
(7) Pawpaw & Orange	P & O	-
(8) Carambola + Pineapple	C & P	-

b. Comparison of the effectiveness of different preservatives

PRESERVATIVE	0 WEEK	2WEEKS	4WEEKS	6 WEEKS
(1) Sorbic acid	No mould growth	No mould growth	No mould growth	No mould growth
(2) Potassium Sorbate	"	"	"	"
(3) Sodium benzoate	"	"	"	"

c. Different levels of preservative

LEVEL OF PRESERVATIVE IN JAM SAMPLE	STORAGE PERIOD					
	0 Week	1 Week	2 Weeks	3 Weeks	4 Weeks	5 Weeks
(1) 0 p.p.m.	-	-	-	-	-	-
(2) 100 p.p.m.	-	-	-	-	-	-
(3) 150 p.p.m.	-	-	-	-	-	-
(4) 200 p.p.m.	-	-	-	-	-	-
(5) 250 p.p.m.	-	-	-	-	-	-
(6) 300 p.p.m.	-	-	-	-	-	-
(7) 350 p.p.m.	NO MOULD GROWTH					
(8) 400 p.p.m.	-	-	-	-	-	-
(9) 450 p.p.m.	-	-	-	-	-	-
(10) 500 p.p.m.	-	-	-	-	-	-
(11) 600 p.p.m.	-	-	-	-	-	-
(12) 700 p.p.m.	-	-	-	-	-	-
(13) 800 p.p.m.	-	-	-	-	-	-
(14) 900 p.p.m.	-	-	-	-	-	-

DISCUSSIONS

Not all the experiments planned could be carried out before the project was suspended. The results obtained show that the following fruits contain enough pectin to form a gel in the presence of sugar and acid; pawpaw, guava carambola and pineapple. However in the case of fruit which are very ripe it is necessary to add additional pectin to the preparation since pectin begins to breakdown as ripening continues.

Results of the experiments on the use of different amounts of preservatives show that jams are able to keep for at least 5 weeks without the addition of any preservative. Thus products containing between 0 p.p.m and 900 p.p.m. of potassium sorbate developed no mould growth after 5 weeks storage.

Since jams are able to store for 5 weeks without developing mould growth, experiments to determine the effectiveness of different preservative within 5 weeks produced no conclusives results. Non of the samples containing 300 p.p.m. of any of the following chemical preservatives; sorbic acid, potassium sorbate and sodium benzoate developed mould growth after 5 weeks storage.

The following series of experiments and objectives listed below were not carried out or investigated due to the suspension of the project.

(1) Preparation of jams with varying percentages of total solids; 50%, 55%, 60%, ... 85% to see which ones went mouldy without the addition of preservatives and how long it took for mould growth to set in.

(2) Experiments designed to monitor changes in soluble solids, insoluble solids, reducing sugars, non-reducing sugars and preservatives both during jam boiling and during storage.

(3) Investigation of the relationship between the minimum level of preservatives and storage temperature.

(4) Investigation of the types and sequence of microbial growth that causes spoilage of the product.

All these experiments would have been carried out using jam and also citrus marmalade.

CONCLUSION

The results are inclusive since most of the experiments designed to solve the problem in the project were not carried out. Pawpaw, guava, carambola and pineapple when they are not too ripe contain enough pectin to form a firm gel in the presence of sugar and acid. Jams are able to store for at least 5 weeks under Ghanaian conditions without the addition of preservatives. Storage beyond this period has not been investigated.

REFERENCES

(1) Crues, W.V., Commercial Fruit and Vegetable Products. 1958 published by McGraw Hill Book Co., New York Toronto, London.

(2) Morris, T.N., Principles of Fruit Preservation 1957. Published by Chapman and Hall, London.

(3) Ghana Standards Board: Ghana Standard Specification for Jams and Jellies.

(4) Ranch. G.H. The Jam Manufacture. 1964. Published by Chapman and Hall, London.