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Food Technology

SHORT COMMUNICATION

Development of sauce from locally available Hog plum (*Spondias dulcis*) in Bangladesh

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A B S T R A C T

The experiment was conducted to develop sauce from fresh Hog plum and studied its storage life. To identify significant factor and base formulation, 3^2 full factorial designs were used. The "one factor at a time" optimization method was used to optimize formulation. The study showed that sugar, vinegar and their interaction have significant effect on overall acceptability in the development of Hog plum sauce. Sugar showed dominating effect on overall acceptability rather than vinegar. Optimal combination of sugar and vinegar were 160 g and 40 ml respectively for per kg raw Hog plum paste to make sauce. Chopped Onion(5%) and Garlic (2%), Cardamom, Black pepper, Cinnamon and Red chili (powdered) 1% of each, clove (head less) about 5 numbers, salt 1.5% and Na- benzoate 0.07% were common ingredient. TSS increased and vitamin C concentration decreased with storage period. The refrigeration temperature (4 ± 1^0C) storage ensured better retention of chemical and sensory properties than room mean temperature (28 ± 2^0C) storage. The storage stability of the Hog plum sauce was higher in refrigeration temperature (120-150 days) than room mean temperature (90-120 days).

INTRODUCTION

Hog-plum (Amra) is an underutilized fruit in Bangladesh. It belongs to the family of Anacardiaceae and its scientific name is *Spondias dulcis*. It is used as food and medicine since time immemorial. Hog-plum is a fruit of mixed taste of sweet and sour which is familiar in botany as Droop. Hog-plum has gained much importance in modern medicine for their pharmacological values (Ayoka et al. 2008). It is very useful for the treatment against bacillary dysentery, tuberculosis infection as it acts as blood purifier. Moreover, it is also effective against scurvy, rickets and some other complex diseases. It helps to reduce serum cholesterol and high blood pressure and has antitumor property. Hog-plum is valuable health food, which are low in calories, high in vegetable proteins, zinc, chitin, fiber, vitamins and minerals. It contains very good amount of Vitamin C.

The use of hog-plum is still unorganized and primitive. Due to poor keeping quality and difficulties of transportation, preservation and marketing facilities, a huge quantity of these valuable fruits are being damaged, spoiled and wasted specially during the peak season. To reduce the wastage and to get a reasonable price by the producer of this fruit, preservation is necessary. By processing products from hog-plum, it can increase the utility of this fruit. Hog-plums are usually eaten raw and can be used for preparation of pickles, chutney and processed food (Akter 2006). It is apparent that research work need to be undertaken for processing and preservation of hog-plum by using locally available machineries and thus low level technology involving minimal capital investment. For long term preservation, processing is considered to be the best method. Therefore sauce may be one of the best methods for processing hog-plum. Sauce is a common and popular product relished for its typical taste and texture as accompaniment with snacks. It is made by concentrating the juice or pulp of the fruits or vegetables without seeds and pieces of skin. It is highly viscous in nature. They also contain more of sugar and less of acid. This study was undertaken with the following objectives (1) to find out optimal formulation of hog-plum sauce, and (2) to study the storage-life of the developed hog-plum sauce.

MATERIALS AND METHODS

The experiment was conducted in the laboratory of the Department of Food Engineering and Technology, State University of Bangladesh. Hog-plum (*Spondias dulcis*)

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collected from local market. The other materials such as salt, sugar, sodium benzoate, onion, garlic, ginger, cinnamon, cardamom, cloves, turmeric powder, cumin powder, red chili powder, and packaging materials were provided from the laboratory stock.

Design of Experiment

Primarily the 3^2 full factorial design was used as strongly recommended by Mon and Li-Chan (2007). The sugar (S) and vinegar (V) were considered as main factors for different formulation of hog plum sauce. Three different levels of sugar (120 g/kg, 150 g/kg and 180 g/kg) and vinegar (30 ml/kg, 40 ml/kg and 50 ml/kg) was used; whereas other ingredients were same for each formulation. The "one factor at a time" optimization method as described by Box and Draper (1987) was also applied. Polynomial model having R^2 value a minimum of 0.85 (Henika 1982) was used to optimize formulation.

Preparation of Sauce

The thoroughly cleaned Hog-plums were peeled, sliced, cored, blanched and the pulping operations were done carefully. The pulp was blended and sieved to get hard fiber less and suitable hog plum paste for sauce preparation. The paste was placed in a stainless steel vessel with spices bag (containing selective spices in specific amount). About one-third quantity of predetermined amount of sugar and salt were added to the paste and mixed thoroughly and then heated until the paste reduced to one-third of its original bulk. After that the spices bag was removed and squeezed to extract its essence and then remaining quantity of sugar and salt were added. The vinegar was added and mixed thoroughly. After that heating was continued to require consistency of total soluble solid (TSS) by using refractometer. To a small quantity of the sauce, sodium benzoate was added at specified rate (0.7g / Kg finished product) as describe described by Srivastava and Kumar (2003) and mixed thoroughly with the rest of the product. The finished product was poured into previously sterilized bottle and sealed and stored at room temperature (28 ± 2^0C) and also at refrigerator (4 ± 1^0C).

Sensory Evaluation

The consumer acceptability of the developed product was evaluated by a taste-testing panel using 1-9 point Hedonic Rating Test (HRT). The panelist scores were analyzed with MSTAT-C software.

Chemical Analysis

Total soluble solids (TSS) and vitamin C content were determined. The analysis was performed according to the AOAC (2005).

RESULTS AND DISCUSSION

Significant factors

As 3^2 full factorial design was used, the effect of main factors and their interaction were analyzed with Factorial ANOVA (Analysis of Variance) as reported by Mon and Chan (2007) to know the significant factor. The main factor Sugar (S) and Vinegar (V) and also their interaction was statistically significant at $P<0.05$, as P value for sugar, vinegar and also their interaction was less than 0.05 from table 1.

Base Formulation

Among the nine primary samples, DMRT was applied as it commonly used in agricultural research (Granato et al. 2011) and the best ranked sample was identified as base sample. From Table 2, the highest score (7.3) was given by combination* S_2V_2, ranked "Like moderately" and identified as base sample. The combination S_3V_2, S_2V_3, $S_2V_1$and S_1V_2 were statistically insignificant at $P<0.05$ as they are suffixed by same letter (b). The difference among the combination S_1V_2, S_1V_3 and S_3V_1 were statistically insignificant as suffixed by same letter (c) at $P<0.05$ but among them S_1V_2 is also in the previous rank due to its suffix. The lowest value (4.5) was found in combination S_1V_1 and it was totally different by rank as suffixed by "e" and preceded by S_3V_3, S_1V_3 and S_3V_1.The formulation of the base sample (S_2V_2) for 1 Kg raw Hog-plum paste was as follows: Onion (chopped) 5%, Garlic (chopped) 2%, Cardamom, Black pepper, Cinnamon and Red chili (powdered) 1% each, clove (head less) about 5numbers, salt 1.5%, sugar 15%, vinegar 40 ml and Na- benzoate 0.07%.

Table 1. Analysis of Variance

Source	Degree of Freedom	Sum of Square	Mean Square	F value	Probability
Replication	9	1.122	0.125	0.3566	
Sugar (S)	2	27.467	13.733	39.2727	0.0000
Vinegar (V)	2	19.400	9.70	27.7387	0.0000
Sugar(S)*Vinegar(V)	4	5.733	1.433	4.0989	0.0048
Error	72	25.178	0.350		
Total	89	78.90			

Table 2. Duncan's Multiple Range Test (DMRT) value for overall acceptability, LSD: 0.5274

Combination	S_1V_1	S_1V_2	S_1V_3	S_2V_1	S_2V_2	S_2V_3	S_3V_1	S_3V_2	S_3V_3
Mean	4.5^{e}	6.0^{bc}	5.6^{cd}	6.3^{b}	7.3^{a}	6.5^{b}	5.7^{cd}	6.5^{b}	5.3^{d}

*For Sugar (S) and Vinegar (V): 1 to 3 correspondence lower to higher level respectively i.e. S_1=120 g kg^{-1}, S_2=150 g kg^{-1}, S_3=180 g kg^{-1} of Sugar and V_1=30 mL kg^{-1}, V_2=40 g kg^{-1}, V_3=50 g kg^{-1} of Vinegar.

Effect of Sugar on Acceptability

From Figure 1, the panelist response changes with change in sugar similarly proposed by Bartoshuk (1977). The complete response trends statistically followed Second Degree Polynomial (SDP) model. The R^2 value of response model was 0.921 and highly accepted as reported by Montgomery (2009) and Henika (1982).

The SDP model describing effect of sugar on overall acceptability is:

Overall acceptability, Y= - 0.001X2 + 0.320X – 17.63 (X= g of sugar)……..…….... (1)

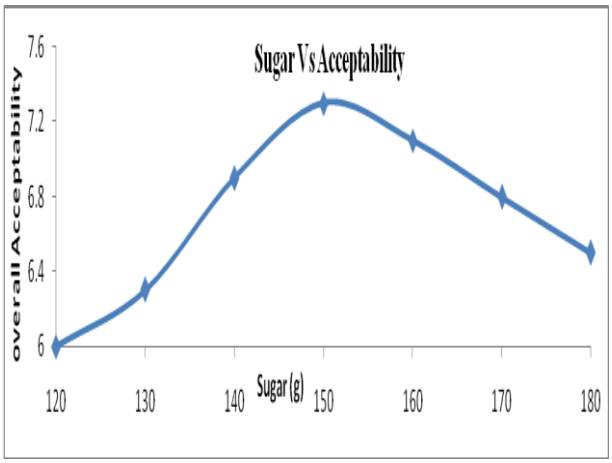

Figure 1. Relationships between sugar and overall acceptability

Effect of Vinegar on Acceptability

From Figure 2, the panelist response changes with change in vinegar. The response trends statistically followed second degree polynomial (SDP) model. The R^2 value of response model was 0.977 and was highly accepted as noted earlier.

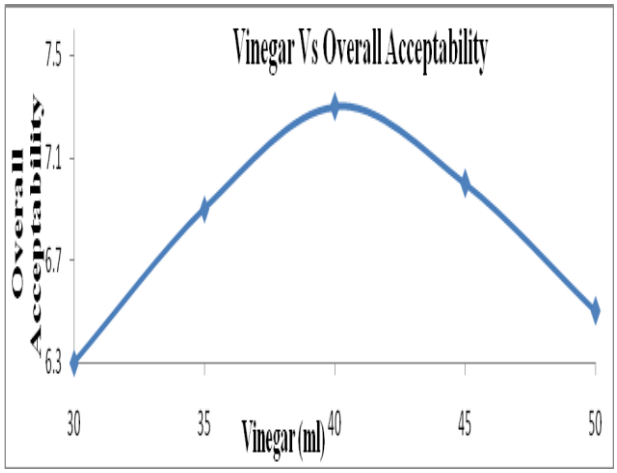

Figure 2. Relationships between vinegar and overall acceptability

The SDP model describing effect vinegar on overall acceptability is:

Overall acceptability, Y= -0.008X2 + 0.672X -6.442 (X= ml vinegar)…..... (2)

Optimal Formulation

The SDP model equation 1 and 2 represent panelist response on overall acceptability for sugar and vinegar respectively. As per equation 1 the highest Y (acceptability) value was 7.97 when X value was 160 g sugar. From equation 2, the highest Y (acceptability) value was 7.67 when X value was 42 ml vinegar. Equation 1 used to optimize formulation, as the Y (acceptability) value 7.97 (near to 8) was greater than 7.67. When tasted the optimized formulated sauce organoleptically, the product ranked as "Like very much" whereas the base sample (S_2V_2) ranked "Like moderately".

Laboratory Attributes

From Table 3, the initial TSS of the sauce was 26.5% and Vitamin C concentration was 4.80 mg/ 100 ml. It was observed that TSS increased and vitamin C concentration decreased as storage time increased. The observation was similar for vitamin C concentration as described by Saron et al. (2007). TSS percentage may be increased due to loss in moisture content during storage and this is in agreement with Barwal et al. (2005). In case of perishable agricultural products, factors responsible for vitamin C losses are; temperature, oxidation, acidity, pH and metal trace (Villota and Hawkes 1992). It was also observed that the changes of TSS and vitamin C were more pronounced in *RMT (28 ± 2^0C) storage than RFT (4 ± 1^0C) storage. These findings are in agreement with Roy et al. (1997), Durojaiye et al. (2003) and Gaffa et al. (2004) who showed that storage at 4 ± 1^0C (RFT) ensure maximum retention of chemical and sensory properties in comparison to storage at higher temperature.

Storage Stability

From table 3, it was observed that loss of vitamin-c was higher in room mean temperature (RMT) in comparison with refrigeration temperature (RFT). After 90 days, vitamin-c loss was 33.12% in RMT and was 28.12% in RFT. And after 120 days, it was correspondingly 40% and 35%. Finally after 150 days, it was 52% and 37%. As overall acceptability consider all the other consumer's quality aspects, the storage life was determined using "paired-t" test, as the period until there was no statistically significant change ($P < 0.05$) in overall acceptability. From Table.4, significant RFT storage life of developed hog plum sauce was more than 120 days as the P value was $0.052 > 0.05$ and less than 150 days as the P value was $0.010 < 0.05$. And the P values also indicate that, significant RMT storage life of the developed hog plum sauce was more than 90 ($0.104 > 0.05$) days and less than 120 ($0.024 < 0.05$) days. From table 3 and 4, it was observed that storage stability was higher in RFT than RMT. This is due to the fact that at higher temperature rate constants for various deteriorative reactions are higher; leading to lower storage stability at RMT (Roy et al. 1997).

Table 3. Changes of TSS and Vitamin C of developed Sauce at (RMT) and (RFT) storage

	RMT (Room Temperature)		RFT (Refrigerator Temperature)	
Days	TSS (%)	Vitamin C (mg/100 ml)	TSS (%)	Vitamin C (mg 100 mL^{-1})
0	26.5	4.80	26.5	4.80
30	26.7	4.08	26.6	4.21
60	26.8	3.79	26.7	3.87
90	26.9	3.21	26.7	3.45
120	27.1	2.89	26.8	3.12
150	27.2	2.31	27.0	2.98

Table 4. The change of overall acceptability of the developed Hog plum Sauce

Panelist	Overall Acceptability										
	0 Day	30 Day		60 Day		90 Day		120 Day		150 Day	
		RMT	RFT	RMT	RFT	RMT	RFT	RMT	RFT	RMT	RFT
1	8	8	8	8	8	8	8	7	8	7	7
2	8	8	8	8	8	8	8	8	8	7	8
3	9	8	9	8	8	7	8	7	7	7	7
4	8	8	8	8	8	8	8	8	8	8	8
5	8	8	8	8	8	8	8	7	7	7	7
6	7	7	7	7	7	7	7	7	7	6	6
7	8	8	8	8	8	8	8	8	8	8	8
8	9	8	8	8	8	8	8	8	8	8	8
9	8	8	8	7	8	7	7	7	7	7	7
10	7	7	7	7	7	7	7	7	7	7	7
P value		0.168	0.343	0.081	0.168	0.104	0.081	0.024	0.052	0.003	0.010

CONCLUSIONS

The optimization of formulation of the hog plum sauce was based on the overall acceptability. Sugar showed most prominent effect on overall acceptability than vinegar. The increase in TSS was directly related with storage period whereas vitamin C concentration change was inversely related. The RFT storage ensured maximum retention of chemical and sensory properties compared to RMT storage. Significant RFT and RMT storage life of sauce was 120 to 150 days and 90 to 120 days respectively.

CONFLICTS OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this paper.

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