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PROCESS STANDARDIZATION AND PHYTOCHEMICAL OF CONTENTS AONLA SQUASH

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***ABSTRACT*:** Response surface methodology tool was used to assess ingredient interaction and model taking into account their respective responses for preparing Aonla squash. Squash was prepared using Aonla juice, sugar and citric acid and response observed were viscosity, taste and overall acceptability. Model capable of predicting the quality of squash were derived. Aonla squash was observed to have better retention of phytochemical: Gallic acid (191.4 mg/100g), ethyl gallate (0.21 mg/100g), ellagic acid (160.4 mg/100g) and quercetin (0.50 mg/100g) as well as sensory characteristics. Ascorbic acid content of squash was 115.6 mg/100g. Product retained fair amount of nutrients and also found acceptable organoleptically.

KEYWORDS: Squash, phytochemical, responses, Gallic acid, ascorbic acid

INTRODUCTION

The demand for processed products of Aonla is steadily increasing in domestic as well as in global market. Aonla has amazing remedial qualities and believed to increase defense against various diseases viz., ulcers, gastrointestinal disorders, heart troubles and diabetes. Additionally, Aonla is useful in enhancing memory, lowering cholesterol and also act as an antimicrobial agent (Khan, 2009). Aonla is also recommended for the treatment of age disorders such as forgetfulness, confusion, fatigue and loss of strength.

Novel processing techniques are required to produce the products of high nutritional quality. In the last decades, food processors are emphasizing on the utilization of natural sources for improving human health and preventing diseases. Aonla being the natural richest source of phytochemical was selected for the preparation of squash.

MATERIALS AND METHODS

Aonla squash was prepared using variety Kanchan as it is a good source of nutrient with good pulp content. Physico-chemical analysis of variety Kanchan reported in study by Parveen and Khatkar, (2015) supported that it was suitable for squash making. Optimization of formula ingredient was done using RSM (response surface methodology

Ingredient used for squash making includes: Aonla pulp, sugar, citric acid and water. Sugar syrup was prepared by dissolving sugar in water with citric acid. Aonla pulp was mixed with syrup and after mixing squash was filtered through muslin cloth. Aonla squash was filled in glass bottles for storage. Level of formula ingredients is reported in Table 1. Box-Benkehn Design of RSM was used for experiment designing and processing. Viscosity is defined as resistance to flow. Viscosity of Aonla squash was measured by standard method of AOAC (2005) using RV-Brookfield viscometer. Viscosity of Aonla squash was determined at 25 ± 0.2^0C using spindle no 3 at 100 rpm. Sample was taken in 600 ml low form Griffin beaker.

Phytochemical content were estimated using RP-HPLC (reverse phase high performance liquid chromatography) using method of Sawant *et al.* (2011) with some modification. Methanolic extract of aonla squash was injected into RP-HPLC and quantification of individual phytochemical was done using peak area of standard and sample. Data was reported in mg/100g of sample.

RESULTS AND DISCUSSION

Model Fitness

The experimental design sheet for squash and their response values obtained are given in Table 1 and fitness of model was evaluated on the basis of F-values (Table 2). The F-values for models of viscosity, taste and overall acceptability (89.89, 49.85, 58.37 and 47.75 respectively) were noted to be significant ($p<0.001$) while the lack of fit was found to be non-significant for all models responses at 95% level. These values suggested that model used for study satisfactorily represented data for responses. Equation for all responses in coded terms is presented in Table 3.

Effect Of Ingredients On Viscosity Of Squash

A quadratic model was observed for gel strength with A, B, A^2, B^2 and C^2 being the significant terms. It was observed that Aonla pulp and sugar were the main factor that significantly affected viscosity and effect of citric acid was non-significant in Aonla squash. Coefficient of viscosity of determination (R^2) was found to be 0.981 and predicted R^2 for viscosity 0.970 was in reasonable agreement with adjusted R^2 0.937 in Aonla squash. The variation in viscosity with Aonla pulp and sugar is presented in Fig 1 (b) and with citric acid and Aonla pulp shown in Fig 1 (a). As shown in the response surface graph 1 (a) and (b), viscosity decreases with increase in sugar while increase was noted with increase in citric acid. Increase in citric acid in Aonla squash causes decrease in pH that justified the increase in viscosity. Results of present finding were in agreement with Nalawade *et al.* (2014) in mango fruit ripple mix. Viscosity of Aonla squash decreased with increase in sugar it might be due to high level of sugar up to 60% reduces the availability of water in pectin-sugar-acid mix thus it reduces the chances of association of pectin with water. At higher level above 60%, more amount of water is increased in squash making it viscous (Basu and Shivhare, 2010). Similar results were reported by Nalawade *et al.* (2014) for viscosity in mango fruit ripple mix.

ANOVA analysis of taste of Aonla squash showed that taste was significantly affected by linear effect of sugar (0.001), Aonla pulp and citric acid (Table 2). Effect of sugar was pronounced more on taste compared to citric acid while reduction was noted in taste with increase in Aonla pulp. As shown in Fig 2 taste of Aonla squash increased sharply with increase in sugar content that might be due to improvement in texture and mouth feel. Similar trend for taste was observed with increase in sugar concentration by Chomped *et al.* (1989) in preparing chocolate flavored peanut beverage applying RSM. Equation explaining behavior of ingredients is presented in Table 3 in coded terms.

Effect of Ingredients on Overall Acceptability Of Squash

ANOVA analysis of overall acceptability of Aonla squash showed that Aonla pulp and sugar has significant (0.001) effect on OA. Effect of sugar was more prominent compared to Aonla pulp. As shown in Fig 3 sharp increase was observed in OA with increase in sugar while effect of Aonla pulp was less. Effect of citric acid was non-significant for overall acceptability. Equation in coded terms for OA is presented in Table 3.

Optimization of Formula Ingredients

To select optimum level of formula ingredients for preparing squash, numerical and graphical optimization was carried out. Viscosity was targeted because higher level is not desirable as it increases the cost as well as health concerns and the selection criteria for responses taste and overall acceptability was kept to maximum. After applying the constraints, optimum level for Aonla pulp, sugar and citric acid obtained is reported in Table 4. Adequacy of the model was verified by carrying out analysis of model prepared using the optimized level of ingredients (Table 4) and comparing them with predicted model terms. Out of five optimized condition 1st was selected on the basis of response value.

Nutritional Composition of Aonla Squash

Aonla squash was found to have 281 mg/100g ascorbic acid, 1.70% total polyphenolic content, 40.51% total sugar content and 1.30% acidity. So it can be concluded that Aonla squash could be a good source of nutrient and could replace the synthetic beverages.

Phytochemical Content of Aonla Squash

Ascorbic acid, gallic acid, ethyl gallate, ellagic acid and quercetin content in Methanolic extract of variety squash were A significant difference ($p<0.05$) was observed in values of ascorbic acid, Gallic acid, ethyl gallate, ellagic acid and quercetin were 115.6, 191.4, 0.21 and 0.50 mg/100g respectively.

Similarly, in French cider apple fruit and juice polyphenolic composition was studied by Guyot *et al.* (2003) using RP-HPLC (UV-VIS detector).

CONCLUSIONS

Aonla Squash good source of ascorbic acid and phytochemical could be used in diet. The optimized level of formula ingredients: Aonla pulp, sugar and citric acid for preparing Aonla squash was 70 g, 131.45 g and 3.0 g, respectively and their predicted response values were in close agreement with analyzed experimental values. So these optimum levels of ingredients could serve as model to produce nutritionally and organoleptically accepted Aonla squash. Further studies are required on Aonla supplementation into different fruits products to enhance their nutritional value.

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Table 1. Experimental design for varying formula ingredients and response values obtained for squash

S. No.	**Aonla pulp (g)**	**Sugar (g)**	**Citric acid (g)**	**Viscosity (cp)**	**Taste**	**OA**
1	90	140	1	743	7.1	7.2
2	110	110	3	708	6.3	6.1
3	90	140	3	745	7.4	7.5
4	70	110	3	720	7	7.2
5	110	140	2	740	6.8	6.5
6	90	110	2	745	6.4	6.5
7	90	110	2	748	6.3	6.4
8	90	80	1	733	5.4	5.5
9	70	110	1	724	6.5	6.5
10	70	80	2	733	5.8	5.5
11	110	110	1	707	5.6	5.6
12	90	110	2	750	6.2	6
13	70	140	2	755	7	7.2
14	90	80	3	730	5.4	5.2
15	90	110	2	746	6.5	6.6
16	90	110	2	747	6.2	6.4
17	110	80	2	721	5	5

OA= Overall acceptability score

Table 2 Analysis of variance for different response models

Source [a]	**Viscosity**	**Taste**	**OA**
Model fitted	Quadratic	Quadratic	Quadratic
F value			
Model	89.89***	58.37***	47.75***
A	*62.67****	*21.96****	*15.75****
B	*87.05****	*145.85****	*79.74****
C	*0.32 NS*	*7.31***	-
AB	-	-	-
BC	-	-	-
AC	-	-	-
A^2	*182.71****	-	-
B^2	*28.66****	-	-
C^2	*171.79****	-	-
Lack of Fit	2.15 NS	2.82 NS	1.79 NS
R^2	0.981	0.930	0.872
Adjusted R^2	0.970	0.914	0.853
Predicted R^2	0.937	0.865	0.797

* Significant at *P* <0.05; ** significant at *P* <0.01; *** significant at *P* <0.001. A= Aonla pulp (g), B= Sugar (g), C= Citric acid (g), OA= Overall acceptability score

Table 3 Predicted equations for different responses

Predicted equations for different responses in terms of coded factors [a]
Viscosity = 747.2 -7 * A + 8.25 * B -0.5 * C -16.475 * A^2 + 6.525 * B^2 -15.975 * C^2
Taste = 6.28824 -0.325 * A + 0.8375 * B + 0.1875 * C
Overall acceptability = 6.28824 -0.4 * A + 0.9 * B

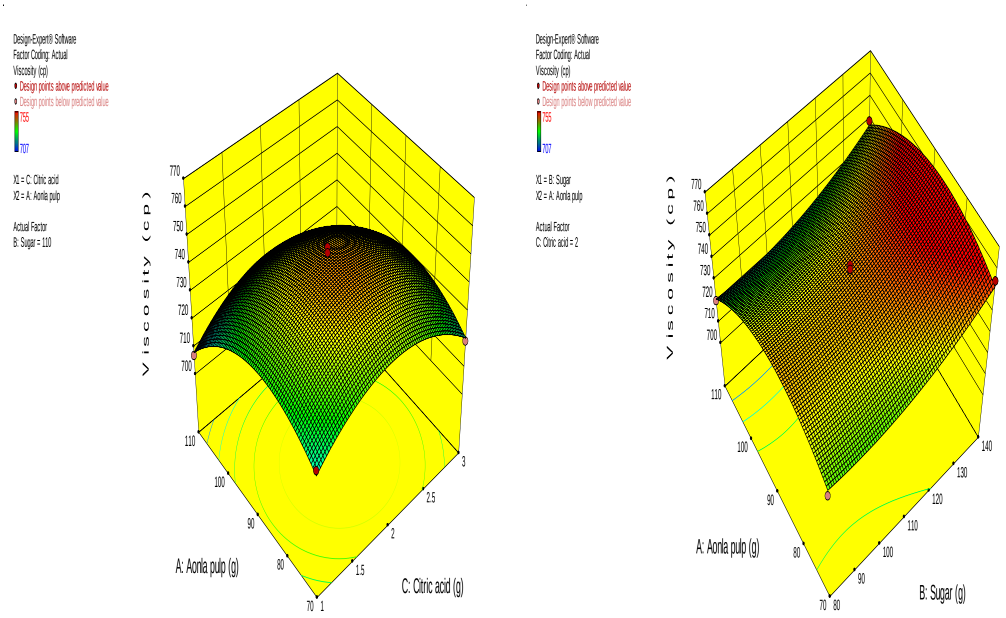
Table 4. Optimized level of ingredients for squash

Number	**Aonla pulp**	**Sugar**	**Citric acid**	**Viscosity**	**Taste**	**OA**	**Desirability**
1	70.000	131.458	3.000	730.489	7.400	7.332	0.868

Table 5. Phytochemical in Aonla squash

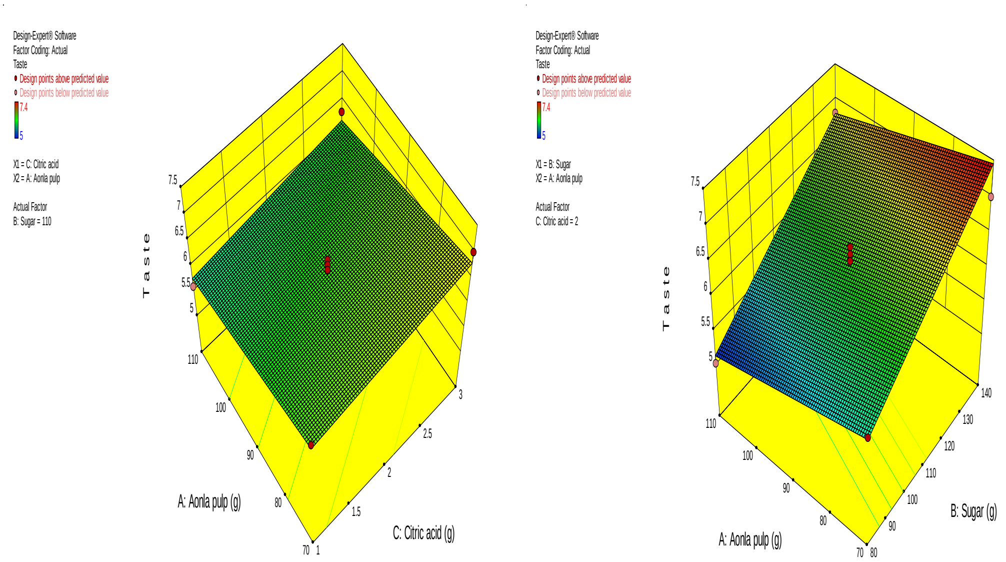
Aonla products	**Ascorbic acid (mg/100g)**	**Gallic acid (mg/100g)**	**Ethyl gallate (mg/100g)**	**Ellagic acid (mg/100g)**	**Quercetin (mg/100g)**
Squash	115.6 ± 1.01ab	191.4± 0.09c	0.21±0.87a	160.4±0.45d	0.50± 0.04b

[a] The values are mean ±SD of determinations made in triplicates. Mean values followed by different letters within a same column differ significantly (p<0.05).



(a) **(b)**

Fig 1. Effect of (a) Aonla pulp& citric acid (b) Aonla pulp & sugar on viscosity of squash



(a) **(b)**

Fig 2. Effect of (a) Aonla pulp& citric acid (b) Aonla pulp & sugar on taste of squash

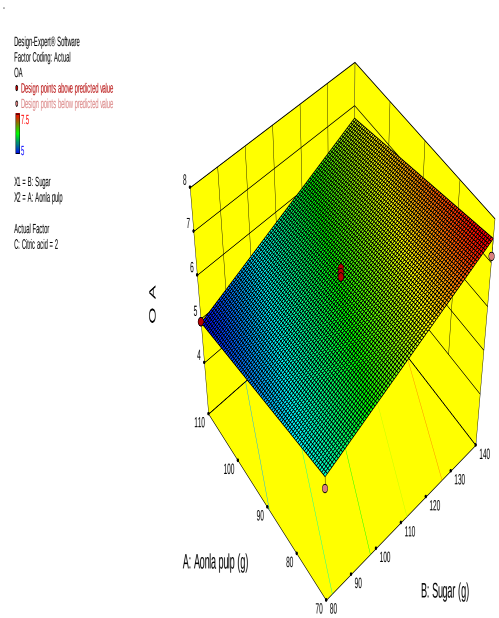


Fig 3. Effect of Aonla pulp & sugar on overall acceptability of squash