

Optimization of Quinoa Seed Powder for Preparation of Sugarfree Burfi by Response Surface Methodology (RSM)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Burfi is Indian most famous milk sweet based on khoa. Quinoa is one of the world's most famous wellbeing food sources. It has gluten, high in protein and one of only a handful of exceptional plant food sources that contain each of the nine fundamental amino acids. Stevia also contains various therapeutic benefits like controls of diabetes, weight loss, regulate blood pressure, prevent cancer, lower cholesterol. This study was carried out to develop a value-added Burfi by replacement of khoa with quinoa flour as well as sugar with Stevia. The improvement of measure of quinoa and Stevia in burfi was finished by Response Surface Methodology strategy utilizing a product of plan master, rendition 8.0. The improvement was finished by focal composite rotatable plan (CCRD), in view of three variables Time, Ph, and Temperature. Design selected for optimization purpose was, for 2 independent variables at five levels of these 2 free factors were chosen based on research centre preliminaries. Level of Quinoa seed powder and stevia has been taken as the variables in planning the examinations and reactions were taken as different boundaries of tactile characteristics like surface, variety, flavour mouthfeel, generally speaking worthiness. There was a great variation observed in organoleptic properties of burfi due to variation in percentage of Quinoa and Stevia. Thirteen samples of burfi were prepared on the basis of CCRD design. Tangible assessment was directed utilizing a semi-prepared board comprising of 25 members, who were aware about the burfi flavour.

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1. INTRODUCTION

Quinoa (*Chenopodium quinoa*) belongs to the *Chenopodiaceae* family. The genus *Chenopodium* is widely present all over the world with around 250 recognized plant species. Quinoa includes more protein content and more balanced amino acid distribution than cereals. Quinoa is a remarkable wellspring of "practical food" that keep us away from the gamble of different illnesses. Its functional characteristics may be associated with the presence of fibre, mineral, vitamins [1-3]. Quinoa is one of the world's most famous wellbeing food varieties. Its sans gluten, high in protein and one of a handful of the plant food varieties that contain every one of the nine fundamental amino acids. These are considered essential as our bodies do not make them and therefore need to be obtained from our diet. Some of the health benefits of stevia includes; controls diabetes, weight loss, regulate blood pressure, prevent cancer, lower cholesterol.

Stevia (*stevia rebaudiana*) is a bushy shrub that belongs to the sunflower family. There are 150 stevia species, all from North and South America. China is the current leading stevia product exporter. Stevia is now manufactured in many nations since stevia is 200-300 times sweeter than table sugar [4,5]. These are the isolated and purified sweet components from stevia leaves. Stevia is the sweetener that include little to no calories. Stevia is utilized in numerous food sources and beverages as a sound option in contrast to added sugar. A portion of the medical advantages of stevia incorporates; controls diabetes, weight reduction, direct circulatory strain, forestall malignant growth, lower cholesterol [6-8].

Among the traditional milk products, khoa is a significant milk product. It is a partly dehydration heat- dehydration milk products that is very common in our nation. Khoa act as a base material to prepare burfi, peda, kalakand etc., sweet based on khoa have longer shelf life and commercial value compared to other sweet. On average, khoa prepared from whole buffalo milk includes 19.20% moisture, 7.10%fat, 17.80 %protein, 21.10% lactose and 3.60%ash [9].

Burfi is Indian most famous milk sweet based on khoa. It has smooth to granular texture with white to light cream in colour. Sugar is included

in different extent and different quantity as indicated by the customer taste and desire. Various types of burfi have been created by territorial inclination with various sort of added substances. There is different sort of burfi sold available relying upon the added substances present viz basic mava, pista, nut, chocolate, rava burfi [10-12]. A wide variety can be noted in actual attributes of market tests. A decent quality burfi has extremely fine grains with a sweet flavour, delicate, oily body and smooth surface. Kho burfi blended with quinoa seed powder is a product, which can be prepared like the traditional indigenous milk burfi where khoa and quinoa seed powder are used in combination. Khoa is responsible for imparting desire texture, flavour and quinoa seed powder provide nutritious value to the product [13-15]. This product is rich in protein, fiber, mineral and antioxidant. It has low glycaemic index which control blood sugar level and gluten intolerant people. Stevia is added as sugar substitute, which make burfi sugar free. This product is good for people suffering from diabetes [16]. The objective of the present study was to optimize the preparation of quinoa seed powder fortified burfi using Response Surface Methodology (RSM).

2. MATERIALS AND METHODS

2.1 Samples Preparation

The experiment was done at the laboratory of food and nutrition, BBAU Lucknow. The quinoa powder, stevia and sugar for the research were purchase from the local market of south city Lucknow. All the equipment, chemical, glassware used for the isolation of quinoa burfi and optimization of quinoa burfi are of analytical grade. All the glassware sterilized properly which were used in a laboratory and proper safety rules were also followed.

2.2 Methods

2.2.1 Preparation of burfi

Control sample was prepared according to the standard burfi preparation method by adding 10% sugar in 100 gm khoa. Treatment 1 was Sugarfree control burfi made by using 4 gm stevia in 100 gm khoa. Treatment 2 was value added Sugarfree burfi, prepared by using 20gm quinoa seed powder in 80 gm khoa and 6 gm of stevia.

The treatment was ready by various mix of khoa quinoa seed powder and stevia acquired from CCRD plan. Trial configuration chose for improvement object was focal composite rotatable plan (CCRD), for 2 autonomous factors of five levels. Levels of these 2 autonomous factors were chosen based on research centre preliminaries. The variable elements considered for RSM studies quinoa (0 - 40) present and stevia (2-5) percent. The full factorial CCRD framework in the coded and the real degree of factors is introduced and all tests were directed in arbitrary order,3 each at a time. the reactions were surface, favour, variety, mouthfeel, generally speaking worthiness. The information was examined utilizing plan master programming (6.0.10 form) and summed up second degree polynomial (condition 1) utilizing the strategy for least square (Snedecor and Cochran, 1968).

$$b_0 + b_1x_1 + b_2x_2 + b_{12}x_1x_2 + b_{11}x_1^2 + b_{22}x_2^2 + c \dots\dots\dots (1)$$

The coefficients of the polynomial models were addressed by b_0 (consistent term) b_1 , b_2 (straight terms) b_{11} , b_{22} (quadratic term) and b_{12} (intuitive terms). Ampleness of model was assessment it was likewise determined to utilize F ratio and confit. Model was viewed as satisfactory when F-calculated was more than table F-value and R_2 was in excess of 70% (Henika 1982) the impact of factors at straight, quadratic and intuitive level on individual reaction was depicted utilizing importance at 1,5 and 10 percent level of certainty.

2.2.3 Sensory evaluation

Sensory evaluation was conducted using a semi-trained panel consisting of 25 members familiar with burfi. The specialists were asked to assess the coded tests for appearances, taste, aroma, texture, flavour, overall acceptability and consistency. Each sensory evaluation was rated on a 9-point hedonic scale (9 =like extremely and 1= dislike extremely) (Ihekoronye and Ngoddy,1985).

3.RESULTS AND DISCUSSIONS

In the present study entitled “functional and nutritional characterization of the burfi prepared with the help of quinoa seed powder and stevia” various treatments formulated on the basis of response surface methodology. Percentage of stevia and quinoa seed powder has been taken as the factors in designing the experiments and

responses were taken as various parameters of sensory attributes like texture, colour, flavour etc. There was a great variation observed in organoleptic properties of burfi due to variation in percentage of Quinoa and Stevia. 13 samples of burfi were prepared on the basis of CCRD design.

3.1 Effect of Percentage of Quinoa and Stevia on Burfi Texture

The Quadratic equation obtained by the response surface analysis of the data showing the effect of percentage of stevia and Quinoa on burfi texture resulted in the following equation:

$$\text{Texture (score)} = +4.02941, +1.21875 * \text{Stevia}, +0.12197 * \text{Quinoa}, +0.000000 * \text{Stevia} * \text{Quinoa}, -0.10156 * \text{Stevia}^2, -5.31250\text{E-}003 * \text{Quinoa}^2.$$

The model was found significant (p value ,0.0001). The coefficient of determination (R2) was 0.8732 which shows a good correlation between the texture score and various proportion of stevia and quinoa. The coefficient of estimation is showing that as the percentage of stevia increasing the texture score is decreasing and the score is increasing with increasing percentage of quinoa upto certain extent. According to the figure there is a change in texture on increasing the quantity of quinoa. As the quantity of quinoa was increased the texture of the sample found to be increasing and after a certain extent it was found decreasing. The texture of burfi was found to be best at 20 gm quinoa in the sample. According to the study from the result obtained, it is revealed that as the levels of quinoa seed powder increase, the score for the body and texture also increases. The present finding can be supported by Gelande et.al (2012).

3.2 Effect of Percentage of Quinoa and Stevia on Burfi Colour

The Quadratic equation obtained by the response surface analysis of the data showing the effect of percentage of stevia and Quinoa on burfi colour resulted in the following equation:

$$\text{Colour (Score)} = -2.010608 * \text{Stevia} +2.70044 * \text{Quinoa}, +0.18598 * \text{Stevia} * \text{Quinoa} -6.25 \times 10^{-3} * \text{Stevia}^2 -5.312 \times 10^{-3} * \text{Quinoa}^2$$

The model was found significant (p value,0.0001). The coefficient of determination

(R2) was 0.8751 which shows a good correlation between the colour score and various proportion of stevia and quinoa. The coefficient of estimation is showing that as the percentage of stevia increasing the colour score is decreasing and the score is increasing with increasing percentage of quinoa upto certain extent. According to the figure there is a change in colour on increasing the quantity of quinoa. As the quantity of quinoa was increased the colour of the sample found to be increasing and after a certain extent it was found decreasing. The burfi colour was found to be best at 20 gm quinoa in the sample. Also, as per the review on utilization of quinoa flour in the creation of gluten - free tarhana by kursat Demir* et al. [17] it was

expressed that level of Quinoa meaningfully affects shade of the end result.

3.3 Effect of Percentage of Quinoa and Stevia on Burfi Flavour

The Quadratic equation obtained by the response surface analysis of the data showing the effect of percentage of stevia and quinoa on burfi flavour resulted in the following equation:

$$\text{Flavour (Score)} = -0.54243 + 2.69018 * \text{Stevia} + 0.13491 * \text{Quinoa} + 6.25 \times 10^{-3} * \text{Stevia} * \text{Quinoa} - 0.24609 * \text{Stevia}^2 - 5.46 \times 10^{-3} * \text{Quinoa}^2.$$

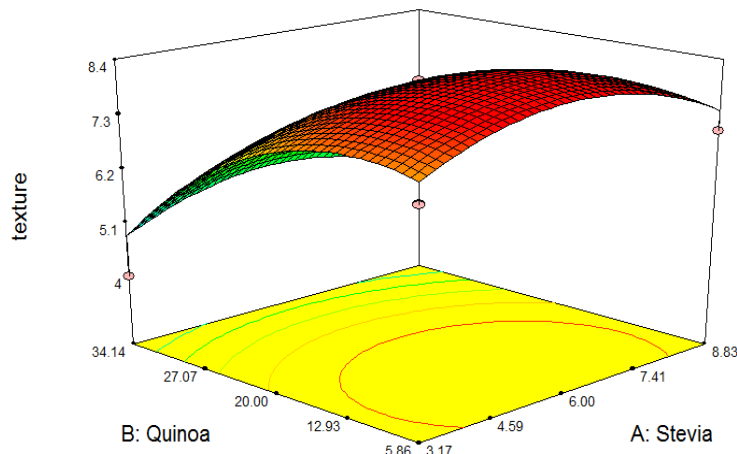


Fig. 1. Effect of percentage of quinoa and stevia on burfi texture

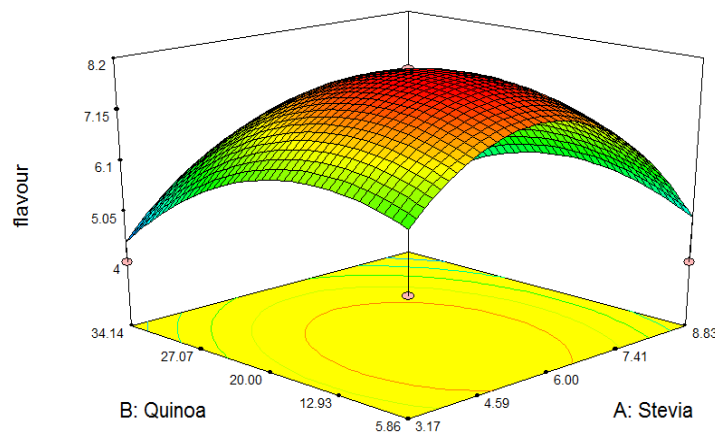


Fig. 2. Effect of percentage of quinoa and stevia on burfi flavour

Table 1. Coded degree of three factors and their genuine qualities

VARIABLES	-α	-1	0	1	+α
STEVIA	2	3.17	6	8.83	10
QUINOA	0	5.86	20	34.14	40

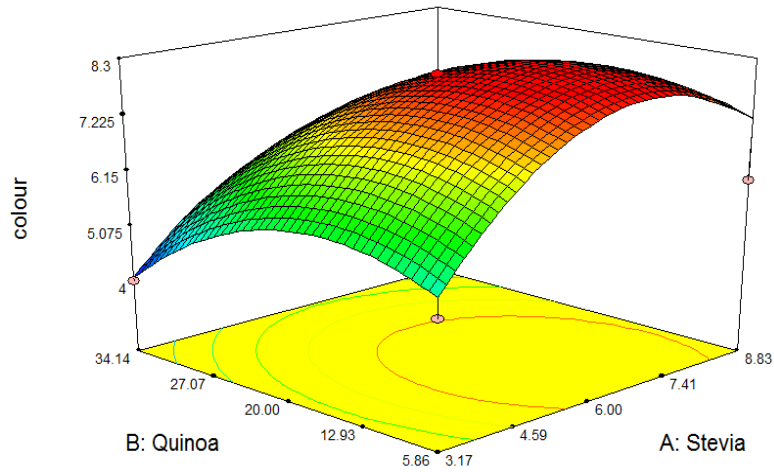


Fig. 3. Effect of percentage of quinoa and stevia on burfi colour

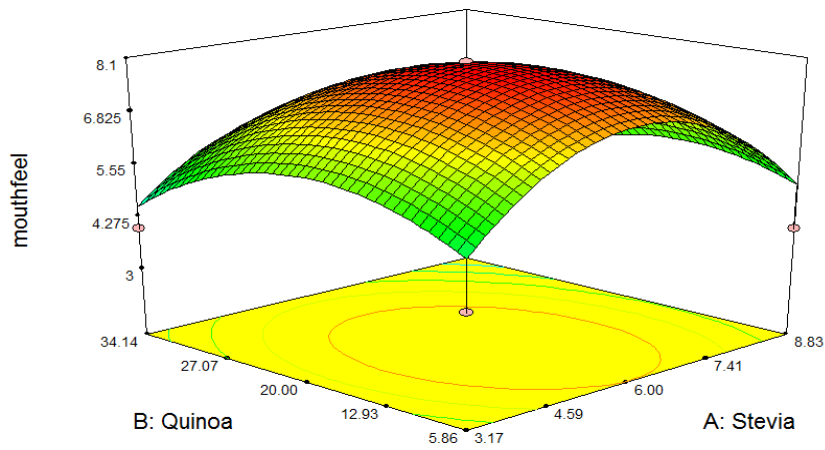


Fig. 4. Effect of percentage of quinoa and stevia on mouthfeel of burfi

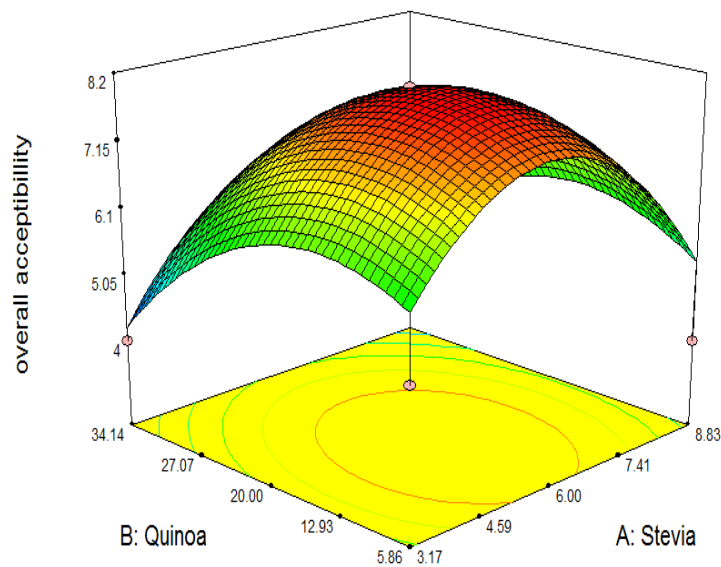


Fig. 5. Effect of percentage of quinoa and stevia on overall acceptability of burfi

Table 2. Design tests of different parameter set by Response surface methodology and the reactions acquired

Std	Run	Block	Factor1A: Stevia	Factor 2 B: Quinoa	Response 1 colour	Response 2 texture	Response 3 flavour	Response 4 mouth feel	Response 5 overall acceptability
1	6	Block 1	3.17(-1)	5.86(-1)	5	7	5	4	5
2	4	Block 1	8.83(1)	5.86(-1)	6	7	4	4	4
3	8	Block1	3.17(-1)	34.14(+ α)	4	4	4	4	4
4	1	Block 1	8.83(1)	34.14(+ α)	4	4	4	3	4
5	9	Block1	2.00(- α)	20.00(+ α)	4	7	5.5	5	5
6	3	Block1	10.00(+ α)	20.00(+ α)	7	7	4	4	5
7	5	Block1	6.00(0)	-0.00(- α)	8	8	8	7.5	8
8	13	Block 1	6.00(0)	40.00(+ α)	5	5	5	5	5
9	2	Block 1	6.00(0)	20.00(+ α)	8	8	8	8	8
10	12	Block 1	6.00(0)	20.00(+ α)	8	8	8	8	8
11	10	Block 1	6.00(0)	20.00(+ α)	8	8	8	8	8
12	11	Block 1	6.00(0)	20.00(+ α)	8	8	8	8	8
13	7	Block 1	6.00(0)	20.00(+ α)	8	8	8	8	8

Table 3. Anova table for a quadratic model of response surface methodology

	Colour	Texture	Flavour	Mouth feel	Overall acceptability
Mean +SD	6.49	4.84	7.36	8.59	6.75
Model	Quadratic	Quadratic	Quadratic	Quadratic	Quadratic
F-value	9.81	9.64	9.81	9.85	7.96
P-value Prob>F	0.0046	0.0048	0.0046	0.0045	0.0084
Lack of fit	4.63	3.51	5.25	6.11	5.94
R ²	0.8751	0.8732	0.8752	0.8756	0.8504
Adj R ²	0.7858	0.7826	0.7860	0.7867	0.7435
CV%	12.74	10.34	14.17	15.87	14.97

Table 4. Anova table for a quadratic model

Source	colour	texture	Flavour	Mouth feel	Overall acceptability
B ₀ (control)	-201608	+4.02941	-0.54243	-3.57368	-0.74556
B ₁ (stevia)	+2.70044	+1.21875	+2.69018	+3.25268	+2.64331
B ₂ (quinoa)	+0.18598	+0.12197	+0.13491	+0.25366	+0.14116
b ₁ . B ₂	-6.25000E-003	+0.000000	+6.25000E-003	-6.25000E-003	+6.25000E-003
b ₁ ²	-0.19531	-0.10156	-0.24609	-0.26953	-0.23438
R ₁ ²	-5.31250E-003	-5.31250E-003	-5.46875E-003	-6.40625E-003	-5.62500E-003
Adj R ²	0.7858	0.7826	0.7860	0.7867	0.7435
CV%	12.74	10.34	14.17	15.87	14.97

The model was found significant (p value, 0.1000). The coefficient of determination (R²) was 0.8752 which shows a good correlation between the flavour score and various proportion of stevia and quinoa. The coefficient of estimation is showing that as the percentage of stevia increasing the flavour score is decreasing and the score is increasing with increasing percentage of quinoa up to certain extent. According to the figure there is a change in flavour on increasing the quantity of quinoa. As the quantity of quinoa was increased the flavour of the sample found to be increasing and after a certain extent it was found decreasing. The burfi flavour was found to be best at 20 gm quinoa in the sample. Similarly, according to the study on preparation of pineapple burfi by banker et.al (2011) from the result obtained it is clear that flavour score is increase with increase in the concentration of quinoa seed powder. The present study has agreement with the study of banker et.al (2011).

3.4 Effect of Percentage of Quinoa and Stevia on Mouthfeel of Burfi

The Quadratic equation obtained by the response surface analysis of the data showing the effect of percentage of stevia and Quinoa on

mouthfeel of burfi resulted in the following equation:

$$\text{Mouthfeel (Score)} = -3.57368, +3.25268 * \text{Stevia}, +0.25366 * \text{Quinoa}, -6.25000\text{E-}003 * \text{Stevia} * \text{Quinoa}, -0.26953 * \text{Stevia}^2, -6.40625\text{E-}003 * \text{Quinoa}^2.$$

The model was found significant (p value,0.1000). The coefficient of determination (R²) was 0.8756 which shows a good correlation between the mouthfeel score and various proportion of stevia and quinoa. The coefficient of estimation is showing that as the percentage of stevia increasing the mouthfeel score is decreasing and the score is increasing with increasing percentage of quinoa up to certain extent. According to the figure there is a change in mouthfeel on increasing the quantity of quinoa. As the quantity of quinoa was increased the mouthfeel of the sample found to be increasing and after a certain extent it was found decreasing. The mouthfeel of burfi was found to be best at 20 gm quinoa in the sample.

3.5 Effect of Percentage of Quinoa and Stevia on Overall Acceptability

The Quadratic equation obtained by the response surface analysis of the data showing

the effect of percentage of stevia and Quinoa on overall acceptability of burfi resulted in the following equation:

Overall acceptability (Score) $-0.74556 + 2.64331 * \text{Stevia} + 0.14116 * \text{Quinoa} + 6.25000E-003 * \text{Stevia} * \text{Quinoa} - 0.23438 * \text{Stevia}^2 - 5.62500E-003 * \text{Quinoa}^2$

The model was found significant (p value, 0.1000). The coefficient of determination (R²) was 0.8504 which shows a good correlation between the overall acceptability score and various proportion of stevia and quinoa. The coefficient of estimation is showing that as the percentage of stevia increasing the overall acceptability score is decreasing and the score is increasing with increasing percentage of quinoa up to certain extent. According to the figure there is a change in overall acceptability on increasing the quantity of quinoa. As the quantity of quinoa was increased the overall acceptability of the sample found to be increasing and after a certain extent it was found decreasing. The overall acceptability of burfi was found to be best at 20-gram quinoa in the sample. It was expressed that level of quinoa significantly affects shade of the eventual outcome.

4. CONCLUSIONS

In the above study, burfi was mixed with stevia and quinoa seed powder. Quinoa seed have higher amount of protein, fiber, mineral and all nine essential amino acid. It has very low level of glycaemic index which is good for diabetic people. It is without gluten quinoa which is beneficial for gluten intolerant people. It has anti-inflammatory, anti-cancer and anti-depressant impact due to plant compound Quercetin and Kaempferol. This above burfi contains natural sweetener stevia which make product sugar free. This study uncovered that Response Surface Methodology was a successful software for the optimization of burfi. The statistical analysis indicates that temperature time and pH affect the yield of quinoa burfi significantly, and also it concluded that quinoa is a good source of nutrition that can be commercially used in the dairy and the dairy product industry. Burfi is consumed by a very large number of people in India. This item is ready with the intent to give nourishment to each individual. However further research work can be carried out on this product to increase its shelf life with improved texture

properties by improving manufacturing process or by using novel packaging.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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