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Studies on effect of quinoa flour on sensorial and textural properties of biscuits

Godse SN[1], Kotecha PM[2], Chavan UD[3]

[1] PhD Scholar, Department of Food Science and Technology, Post graduate Institute, MPKV, Rahuri, Ahmednager, Maharashtra, India

[2] Assistant Professor, Department of Food Science and Technology, Institute MPKV, Rahuri, Ahmednager, Maharashtra, India

[3] Head, Department of food Science and Technology, Post graduate Institute, MPKV, Rahuri, Ahmednager, Maharashtra, India

Abstract

The entire present investigation was carried out to determined effect of different level of quinoa flour on textural and sensorial properties of biscuits. Moreover, the biscuit is one of the most popular bakery food product however it is made from maida so maida has various harmful effect on human health hence it is obligatory to find the alternative for maida so the quinoa flour has been incorporated at various proportion and moreover it has also good nutritional value over Maida hence the present investigation's basic motto is to see the effect of quinoa flour on textural and sensorial properties of biscuits. Because these two parameters play an vital role in bakery product acceptability. At present research the various level of quinoa flour has been incorporated with the help of response surface methodology as 25%, 35%, 19.34%, 45% and 50.65% etc among that it was found that 25% quinoa flour has very good sensorial as well as textural properties

Keywords: Quinoa, texture sensory Response surface methodology (RSM)

Introduction

Bakery industry has a very important role to play in economic development of the country and also in building the health of people. The nutritional significance of the bakery products is well recognized. Attempts are being made to enrich the products with high quality non-wheat flours, which are ready to eat, convenient, inexpensive. To attract consumers, traditional products must be reformulated to meet demands for fast preparation time, convenience and health significance. Biscuits and Cake formulation offers an easiest opportunity of fortification of other cereals, oilseed and legumes flour for product preparation. Quinoa (*Chenopodium quinoa Willd*) belongs to family Chenopodiaceae, class Dicotyledoneae, genus Chenopodium, and species quinoa. Quinoa is a dicot plant that can grow from 1to 3 m high, it is considered a pseudo-cereal, not a true grain but rather a fruit. The seeds are round and flat, about 1.5-4.0 mm in diameter and their color varies from white to grey and black, with tones of yellow, rose, red, purple and violet. Quinoa has demonstrated a strong tolerance to salty, acid or alkaline soils, in both cold (-5°C) or hot climates (up to 35°C). The major quinoa producing countries are Bolivia, Peru and Ecuador. Outside South America, quinoa is grown in the USA (Colorado and California) and in Canada. It is also cultivated experimentally in Finland and the UK. Quinoa grains have an established excellent nutritional food quality and also called "the chisya mamaor mother grain" and is nowadays also called Incan rice (Taylor and Parker, 2002).Quinoa is considered one of the best vegetal protein sources, as its protein levels are similar to those found in milk and higher than those present in cereals such as wheat, rice and maize. Quinoa flour is lowing luten due the low contents of prolamines and glutamines. The seed protein content is high (about 15%), and its essential amino acid balance is excellent because of a wider amino acid spectrum than cereals and legumes (Ruales and Nair, 1992), with higher lysine (5.1- 6.4%). and methionine (0.4-1.0%) contents (Bhargava *et al*., 2003) [3].

It is an important source of vitamins and minerals, Quinoa grains have vitamins C, E (tocopherols) and B complex and important minerals (Ca, K, Fe, Mg, Mn, P), and has also been found to contain compounds like polyphenols, phytosterols and flavonoids with possible nutraceutical benefits, isoflavons and high quality lipids. Starch is the major componen t of quinoa, comprising approximately 55% of the seed.

It is present in the form of small granules about 1.5 µm in diameter (Chauhan *et al*., 1992) [5, 6].

India is currently the world's largest biscuit consuming nation. The industry is expected to grow at a CAGR of 14 per cent till financial year 2019.The top four players in the market for biscuits and cookies are Parle Products, Britannia, ITC and Surya Foods and Agro. Biscuit are easier to manufacture, have a long shelf life, are easier to transport and can be available everywhere. It is also profitable to sell in rural areas if the pricing of the packet is low and size is individual.

Materials and Methods

The basic raw material required for processing like quinoa flour, wheat flour, shortening, sugar etc were purchased from local market of rahuri and Most of the chemicals used in this investigation were obtained from M/s British Drug House, Mumbai, M/s Dodal Enterprises, Aurangabad, E-merk (India) Limited, Mumbai - 400 018, Qualigen Fine Chemicals, Galaxo Smith Kline Pharamaceuticales Limited, Mumbai 400 025, Thermo Fisher Scientific India Pvt Ltd., 403 404, B-wing Delphi, Hiranadani Business Park Powai, Mumbai 400 076, Fine Chemicals Limited, Ahemedabad –

380 006 (India).

Methods

The various methods are used to determined textural, physicochemical and nutritional properties of quinoa flour incorporated biscuits.

Textural analysis (Hardness test) of biscuits

Hardness of biscuits was measured by using cylindrical probe P/2 of Instron Universal Texturometer, AG X, Shimadzu Japan, capacity 2500N. The individual samples of biscuits were placed on the platform and the probe was attached to the crosshead of the instrument. The TA setting was kept at: pre-test speed of 5mm/min. The initial significant peak force from the resulting curve was considered as the initial fracture force and the absolute peak force was considered as the hardness of biscuits (Bourne, 2002 [4]; Singh *et al.*, 1993) [15].

Gluten content

The gluten content (wet and dry) of whole wheat flour and composite flour mix was determined by AACC (1984) [1]. method

Moisture content

The moisture content of sample was determined by (AOAC, 1990) [2].

Protein content

The protein content was determined by Micro-Kjeldahl method (AOAC, 1990) [2].

Ash content

The ash content of the biscuit was determined by AOAC 1990 [2].

Carbohydrate

The content of carbohydrate in the selected samples were obtained by subtracting from 100, the sum of values of moisture, protein, fat, ash and crude fiber content per 100 g of the sample (Raghuramulu *et al.*,1993).

Results and Discussion

Table 1: Chemical compositions of composite whole wheat and quinoa flour

S.N.	Characteristics	Whole wheat flour	Quinoa flour
1	Moisture (%)	5.65	3.91
2	Crude protein (%)	12.25	9.62
3	Crude fat (%)	2.2	7.4
4	Carbohydrates (%)	77.5	76.61
5	Crude fibre (%)	0.8	0.2
6	Ash (%)	1.6	2.26
7	Phosphorus mg/100g	89	140
8	Magnesium mg/100g	86	14

Each value represents the average of three determinations

The chemical composition of whole wheat flour and quinoa flour used in the investigation is given in Table 1. The moisture, crude protein, crude fat, carbohydrates, crude fiber, total ash, phosphorus and magnesium contents of whole wheat flour were 5.65, 12.25, 2.2, 77.5, 0.8, 1.6 per cent and 89, 86 (mg/100g) respectively. Haridas Rao *et al.*, (1976) [9] reported the moisture and protein content of whole wheat flour to be 6.5-11.9 and10.6-16.8 per cent respectively. Finney *et al.*, (1950) and Hoojjat and Zabik (1984) [10] reported very close values of fat and carbohydrate content in wheat flour to be 2-2.3 and 76.8 percent respectively. Lorenz (1983) and Hoojjat and Zabik (1984) [10] reported the fiberand ash content in wheat flour to be 0.3 and0.4 per cent respectively, which indicates that present findings are in conformity with the reported results.

The findings presented in Table 1 also reveal the results of chemical composition of quinoa flour. The moisture, crude protein, crude fat, carbohydrates, crude fiber, total ash, phosphorus and magnesium contents of quinoa flour were 3.91%, 9.62%, 7.4%, 76.61%, 0.2%, 2.26%,140 mg/100g and 14mg/100g, respectively. The similar findings of chemical compositions are also reported by Chavan (1992) [6] and Nisar *et al.*, (2018) [12].

Table 2: Hardness and color of whole wheat and quinoa flour biscuits

Expt. No	Hardness (N)	Colour				
		L*	a*	b*	C*	H*
1	79.60	65.01	2.91	22.74	22.93	82.67
2	29.22	62.87	2.98	23.09	23.28	82.59
3	106.18	66.42	2.17	21.20	21.31	84.11
4	96.15	63.51	2.38	22.35	22.48	83.87
5	135.24	65.50	2.83	24.14	24.31	83.27
6	76.07	64.51	2.84	23.91	24.08	83.17
7	35.47	65.58	2.85	21.68	21.86	82.46
8	113.91	63.99	1.59	22.74	22.80	85.96
9	64.21	66.31	3.08	22.02	22.24	81.99
10	8.32	62.88	2.07	20.96	21.06	84.32
11	141.21	67.33	3.19	24.12	24.33	82.41
12	14.49	62.47	3.50	23.47	23.73	81.47
13	16.27	64.07	2.59	19.86	20.03	82.53
14	122.53	62.38	2.12	24.14	24.23	84.94
15	38.20	66.81	3.33	23.71	23.94	81.95
16	34.83	62.00	1.95	24.10	24.18	85.32
17	32.78	59.70	2.49	20.63	20.78	83.08
18	90.43	62.55	2.31	25.12	25.23	84.69
19	66.73	66.14	3.80	23.62	23.92	80.81
20	18.78	62.49	2.10	26.16	26.24	85.36
21	47.28	65.35	3.52	23.52	23.79	81.43
22	104.43	61.87	3.57	25.98	26.23	82.14
23	51.23	59.05	2.93	21.10	21.30	82.04
24	134.88	62.70	1.86	25.87	25.94	85.84
25	23.97	67.44	2.31	31.32	31.40	85.74
26	53.31	63.96	1.55	25.63	25.68	86.49
27	15.23	56.41	4.56	20.40	20.90	77.35
28	77.42	63.13	2.63	26.45	26.58	84.28
29	51.29	63.12	6.39	25.25	26.05	75.77
30	61.66	61.99	2.23	25.06	25.16	84.86
31	28.81	65.15	4.39	25.52	25.90	80.19
32	26.92	60.80	1.83	23.88	23.95	85.56
33	52.04	57.63	6.09	23.31	24.09	75.31
34	52.87	65.38	2.35	23.01	23.13	84.13
35	44.21	60.88	4.19	26.42	26.75	80.95
36	101.45	63.44	3.37	23.75	23.99	81.87
37	82.24	65.83	2.75	24.80	24.95	83.63
38	16.35	64.35	3.71	24.95	25.23	81.51
39	23.93	63.19	2.50	23.57	23.70	83.89
40	32.85	64.31	4.89	25.87	26.33	79.25
41	53.50	53.80	5.34	20.07	20.77	75.05
42	38.35	62.74	3.78	24.67	24.95	81.24
43	34.05	61.84	4.36	24.04	24.43	79.68
44	73.69	61.80	3.77	23.57	23.87	80.86
45	30.43	59.28	2.11	19.91	20.02	83.89
46	30.43	59.28	2.11	19.91	20.02	83.89
47	30.43	59.28	2.11	19.91	20.02	83.89
48	30.43	59.28	2.11	19.91	20.02	83.89
49	30.43	59.28	2.11	19.91	20.02	83.89
50	30.43	59.28	2.11	19.91	20.02	83.89
51	30.43	59.28	2.11	19.91	20.02	83.89
52	30.43	59.28	2.11	19.91	20.02	83.89

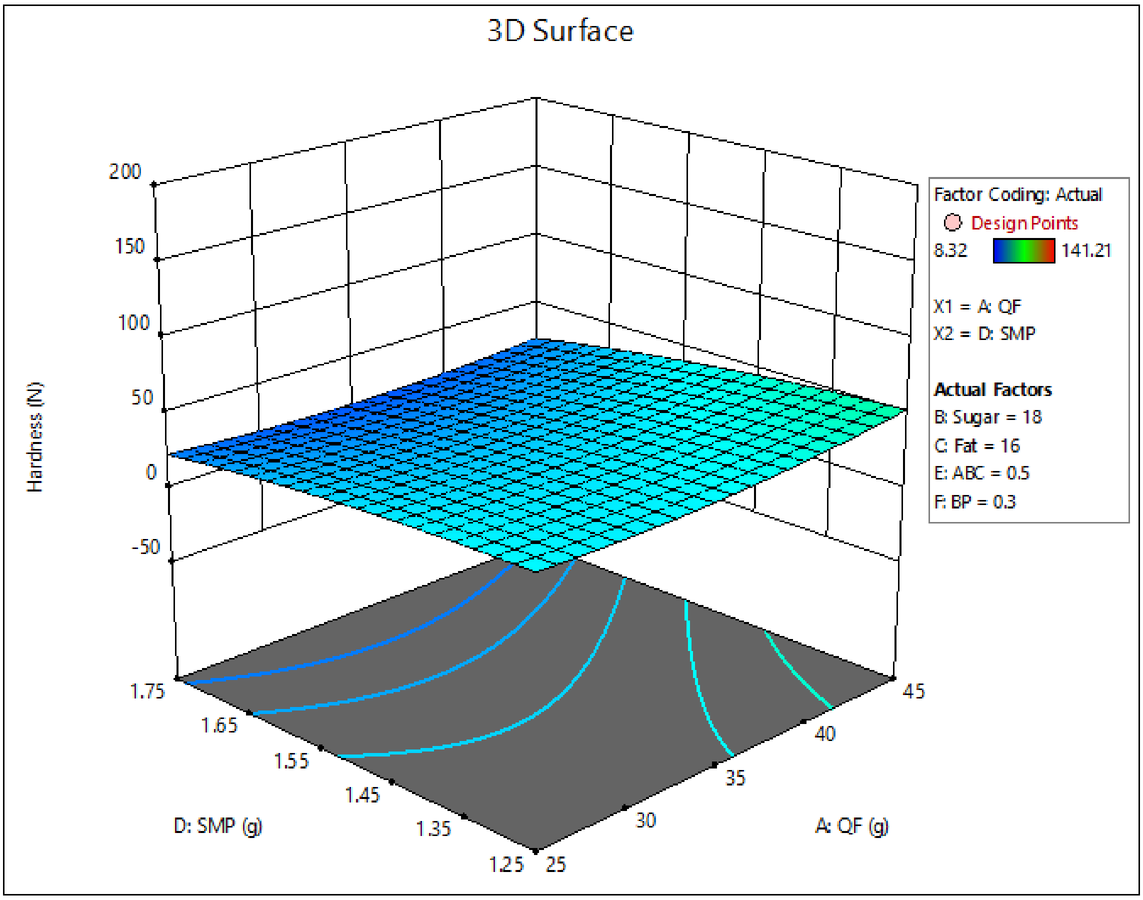

Fig 1: Interactive effect of quinoa flour and skim milk powder on hardness of biscuit

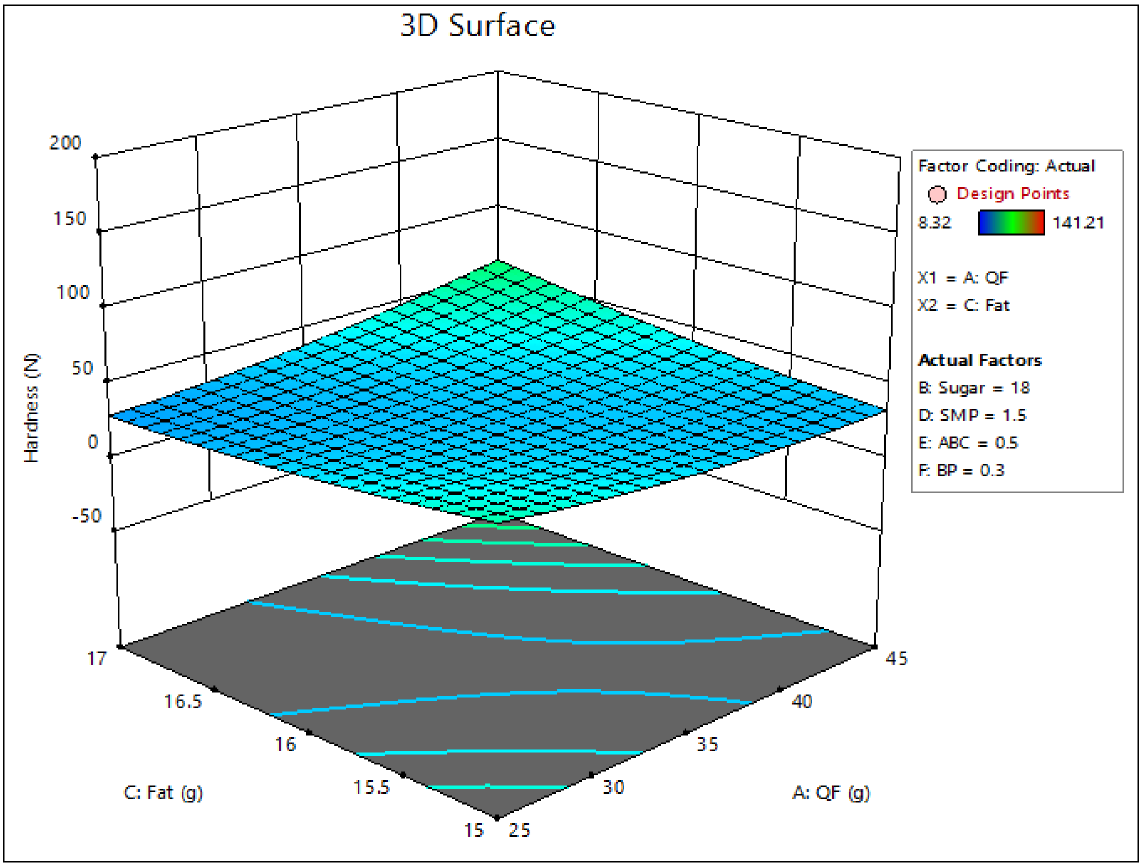

Fig 2: Interactive effect of quinoa flour and fat on hardness of biscuit

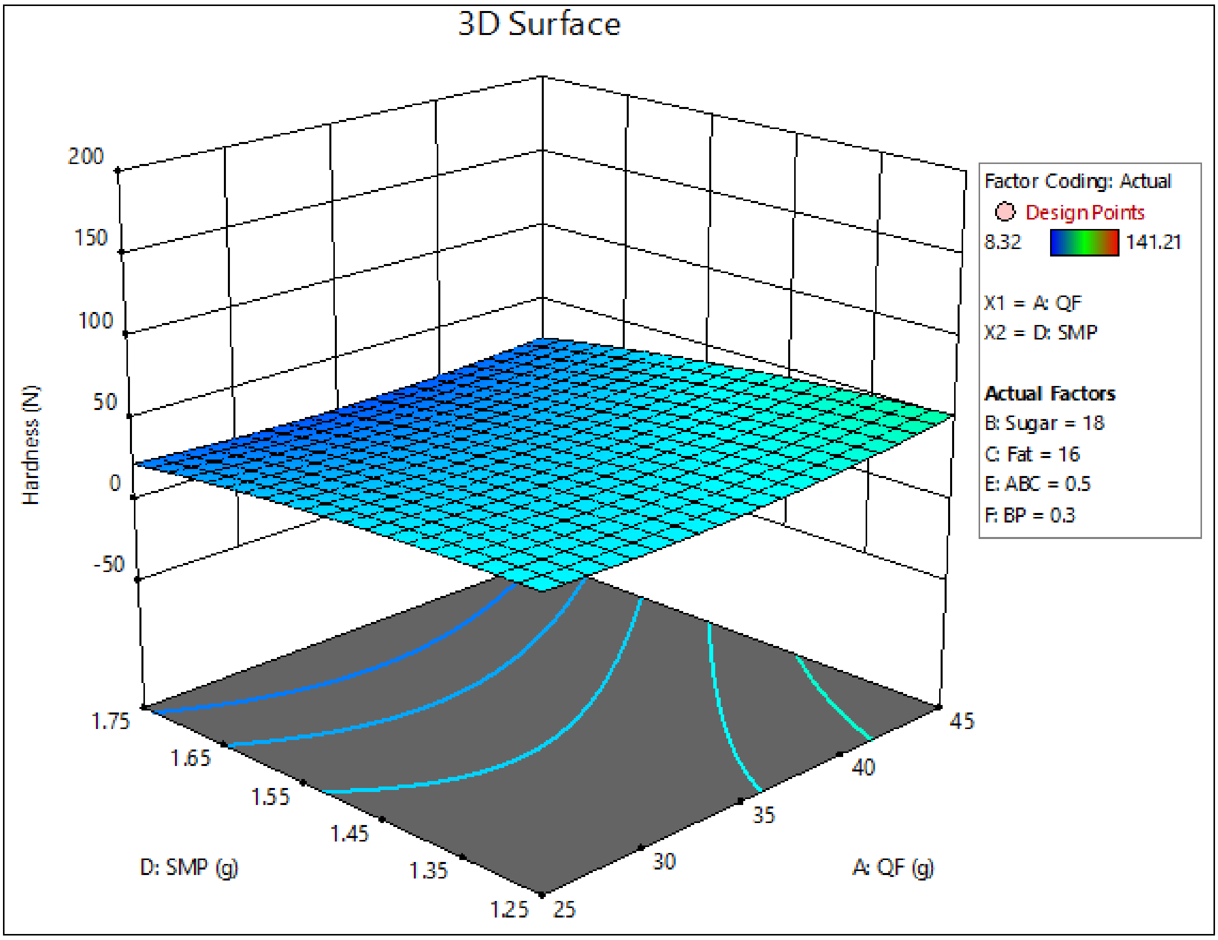

Fig 3: Interactive effect of quinoa flour and skim milk powder on hardness of biscuit

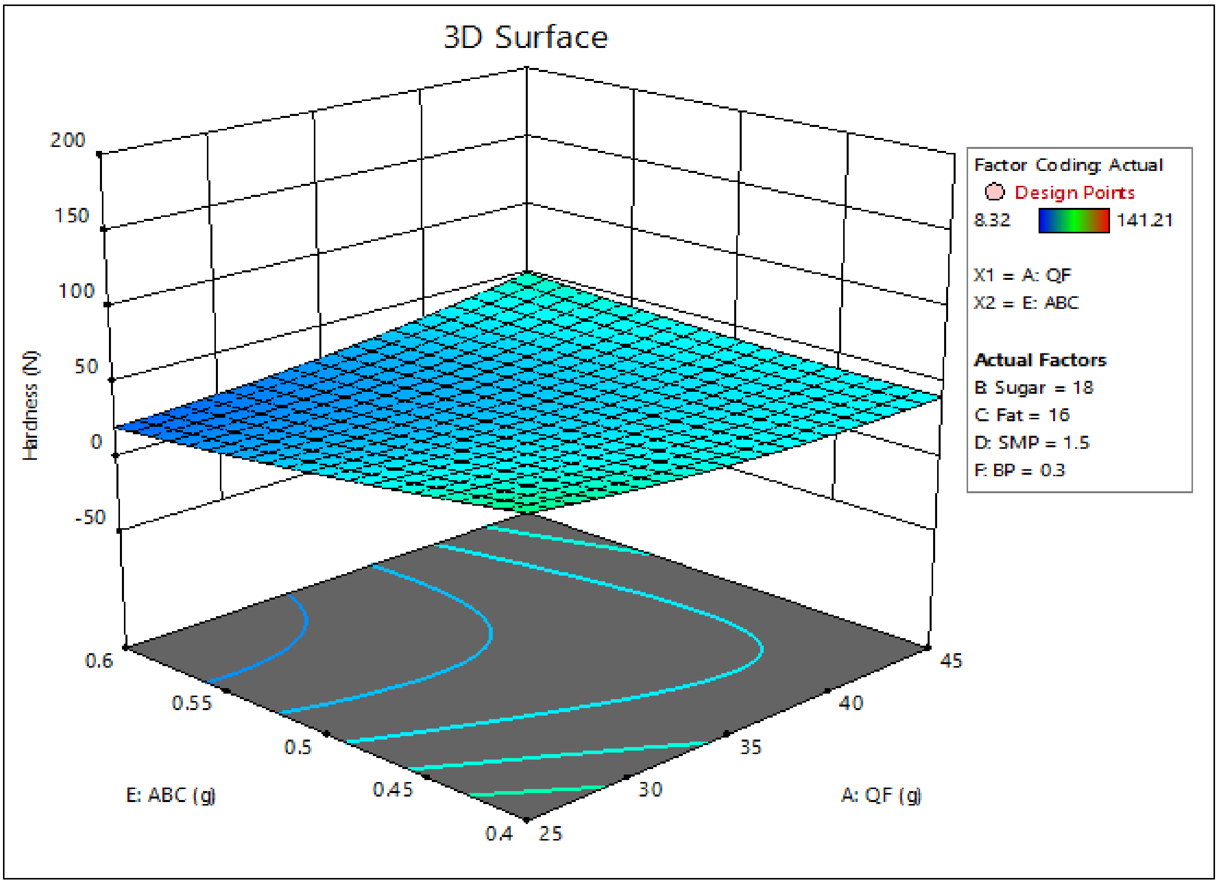

Fig 4: Interactive effect of quinoa flour and ammonium bi carbonate on hardness of biscuit

Table 2: Regression coefficient of full second order model and significant terms for textural and color parameters of whole wheat and quinoa flour biscuits

Constant	Hardness (N)	Colour				
		L*	a*	b*	C*	H*
	34.33	59.88	2.96	21.32	21.55	82.24
Linear						
$\beta_1 BX_1$	3.55	-0.3567	0.5876	0.4773	0.3891	1.54
β_2 BX_2	2.53	-0.0413	-0.0546	-0.3030	-0.3100	0.0201
β_3 BX_3	1.57	-0.1644	0.1163	0.0383	0.0569	-0.1929
β_4 BX_4	-11.54**	0.0207	0.2258	0.4239	0.4606	-0.4223
β_5 BX_5	-6.79	-0.4281	0.0989	1.04	1.05	0.0620
β_6 BX_6	0.5661	-0.6844	0.0614	-0.3630	-0.3463	-0.2351
Interactive						
$\beta_{1.2}$ BX_1X_2	-1.91	0.528	-0.0916	0.2894	0.2819	0.3006
$\beta_{1.3}$ BX_1X_3	12.91***	-0.1091	-0.1828	0.1163	0.0912	0.4137
$\beta_{1.4}$ BX_1X_4	-2.78	-0.2741	-0.2528	-0.4719	-0.5094	0.4862
$\beta_{1.5}$ BX_1X_5	11.61**	0.6109	-0.2747	0.2344	0.1900	0.7050
$\beta_{1.6}$ BX_1X_6	-4.72	0.6347	-0.0391	0.4750	0.4612	0.2137
$\beta_{2.3}$ BX_2X_3	-.953	0.0034	-0.3122	0.0150	-0.0281	0.7225
$\beta_{2.4}$ BX_2X_4	-1.65	-0.3303	0.2128	0.0569	0.0762	-0.4850
$\beta_{2.5}$ BX_2X_5	-2.94	-0.4591	0.0059	-0.3756	-0.3769	-0.1513
$\beta_{2.6}$ BX_2X_6	-13.12***	-0.2816	-0.1647	-0.2950	-0.3169	0.2425
$\beta_{3.4}$ BX_3X_4	-6.13	-0.1084	0.0341	-0.2150	-0.2069	-0.0644
$\beta_{3.5}$ BX_3X_5	2.96	0.0053	0.2234	-0.2337	-0.2025	-0.5044
$\beta_{3.6}$ BX_3X_6	14.32***	0.2978	0.478	0.4844	0.4887	0.0681
$\beta_{4.5}$ BX_4X_5	0.7453	0.1653	0.0634	0.3431	0.3594	-0.0619
$\beta_{4.6}$ BX_4X_6	0.8916	0.0451	0.2128	-0.1600	-0.1231	-0.5544
$\beta_{5.6}$ BX_5X_6	-9.79**	-0.9034	0.0484	-0.6950	-0.6775	-0.2994
Quadratic						
$\beta_{1.1}BX_1X_1$	5.61	0.3855	0.1249	0.0998	0.1397	-0.2723
$\beta_{2.2}$ BX_2X_2	13.92	0.6529	-0.0547	0.8856	0.8582	0.4176
$\beta_{3.3}$ BX_3X_3	4.32	1.85	-0.2792	0.7999	0.7439	0.8921
$\beta_{4.4}$ BX_4X_4	-4.22	1.30	-0.0894	0.7366	0.7133	0.4829
$\beta_{5.5}$ BX_5X_5	2.94	-0.9352	-0.2638	-0.2227	-0.1665	-0.9153
$\beta_{6.6}$ BX_6X_6	6.18	0.5141	0.0617	0.3631	0.3601	-0.0478

***Significant at 1 %, **Significant at 5 %, BX_1-WWF: QF, BX_2-Sugar, BX_3-Fat, BX_4-Skimmed milk powder (SMP), BX_5-Amonoum bicarbonate (ABC), BX_6-Baking powder (BP).

Table 3: ANOVA for full second order regression model for textural and color parameters of whole wheat and quinoa flour biscuits

Source	Hardness (N)	Colour				
		L*	a*	b*	C*	H*
Model S.S.	46584.89	265.12	32.52	188.00	183.50	206.37
Model MS.	1725.37	9.82	1.20	6.96	6.80	7.64
Model DF	27	27	27	27	27	27
Error S.S.	16369.80	171.12	29.31	106.64	115.03	134.59
Error MS	682.08	7.13	1.22	4.44	4.79	5.61
Error DF	24	24	24	24	24	24
F ratio	2.53	1.38	0.99	1.57	1.42	1.36
F Table	1.95	1.95	1.95	1.95	1.95	1.95
R Square %	74.00	60.77	52.59	63.81	61.4	60.53
Std. Dev. (S.D.)	26.12	2.67	1.11	2.11	2.19	2.37
Mean	54.73	62.56	2.98	23.21	23.43	82.64
C.V.%	47.72	4.27	37.12	9.08	9.35	2.87

The effect of different ingredient and their combination on hardness of biscuit is given in Table 3 and presented through Fig.4.42 to 4.62. The minimum and maximum hardness was 8.32 and 141.21 N was recorded in Expt. 10 and 11 (Fig4.63 and 4.64) respectively, which represented 19:45g, 17g, 15g, 1.75g, 0.4g, 0.20g, and 39:25, 19g, 15g, 1.75g, 0.4g, 0.20g of WWF:QF, sugar, fat, SMP, ABC and baking powder, respectively. The F-ratio and its table value are given in Table 4.8 the table indicates that F-ratio (2.53) was higher as compared to table value of 1.95. The R^2 value of perdition model was 74%. The finding indicates that model was significant and could explain more than 74% variability in the experiments. The model was considered adequate and further analysis of model terms.

The coefficients of regression model presented in Table 4.7 described that different levels of skimmed milk powder had negative linear significant effect at 5% level of confidence on hardness of biscuits. The interactions found to be significant were quinoa flour–fat (1%), quinoa flour-ammonium bi carbonate (5%), sugar-baking powder (1%), fat-baking powder (1%) and ammonium bicarbonate – baking powder (1%) level of confidence. Rest all other linear, interactive and quadratic terms of model was non-significant even at 10% level of significance. The similar finding of increase in hardness of biscuits by replacement of wheat flour with quinoa flour has also been reported by Demir and Kilinc (2017) [7].

Colour

L^*(Darker)

The effect of different ingredient and their combination on Hunter colour value, L* (Darker) of biscuits are is given in (Table 1.). It varies from 59.05 to 67.44 in Expt. 23 and 25 respectively, which represented the combination of ingredients to be 39:25g, 19g, 17g, 1.25g, 0.6g, 0.40g and 39:25g, 17g, 15g, 1.75g 0.6g 0.20g of WWW:QF, sugar, fat, SMP, ABC and baking powder, respectively. The table 4.8 shows that, F-ratio (1.38) was lower as compared to table value 1.95. The R^2 value of perdition model was also lower 60.77%. The finding indicates that model was found non-significant and could explain more than 60.77% variability in the experiments. Hence the model was not found adequate for further analysis. The non-significant effect is might be due to the fact that L value decreased with increase in levels of addition of quinoa flour (Thejasri *et al.*, 2017) [16].

a^*(Green)

The effect of different ingredient and their combination on a* (Green) colour values of biscuits are given in (Table 1) The minimum and maximum a^* (Green) value was 1.55 and 6.39 recorded in Expt. 26 and 29 respectively, which represented the combination of ingredients to be 19:45g, 17g, 15g, 1.75g, 0.6g, 0.40g and 39:25g, 17g, 17g, 1.75g 0.6g 0.40g of WWF:QF, sugar, fat, SMP, ABC and baking powder, respectively

The Analysis of variance Table 4.8 shows that, F-ratio (0.99) was lower as compared to table value 1.95. The R^2 value of perdition model was also lower 52.59%. The finding indicates that model was found non-significant and could explain more than 52.59% variability in the experiments. Hence the model was not found adequate for further analysis. The present findings could not be confirmed due to unavailability of reported results.

4.2.1.6.3 b^*(Yellow)

The Table 1. comprises the results of effect of different ingredient and their combination on b* (Yellow) colour values of biscuits. The minimum and maximum b^* (Yellow) colour value was recorded in Expt. 13 (19.86) and Expt.25 (31.32) respectively, which represented the combination of ingredients to be 39:25g, 17g, 17g, 1.75g, 0.4g, 0.20g and 39:25g, 17g, 15g, 1.75g, 0.6g, 0.20g of WWF:QF, sugar, fat, SMP, ABC and baking powder, respectively.

The Analysis of variance Table 3 shows that, calculated value of F-ratio (1.57) was lower as compared to table value 1.95. The R^2 value of perdition model was also lower 63.81%. The model could explain 63.81% variability in the experiments. The finding indicates that model was found non-significant. Hence the model was not found adequate for further analysis. The present findings could not be confirmed due to availability of reported results

4.2.1.6.4 C*(Brighter)

A perusal of Table 1. shows the effect of different ingredient and their combination on C* (Brighter) colour values of biscuits. The minimum and maximum C* (Brighter)value was 20.02 and 31.40 was recorded in Expt. 45 to 52 and 25 respectively, which represented the combination of ingredients to be 29:35g, 18g, 16g, 1.5g, 0.5g, 0.30g. and 39:25g, 17g,15g, 1.75g, 0.6g, 0.20g of WWF:QF, sugar, fat, SMP, ABC and baking powder, respectively

The Analysis of variance table 3 shows that, F-ratio (1.42) was lower as compared to table value 1.95. The R^2 value of perdition model was also lower 61.4%. The finding indicates that model was found non-significant and could explain more than 61.4% variability in the experiments. Hence, the model was not found adequate for further analysis. The present findings could not be confirmed due to availability of reported results.

4.2.1.6.5 H*(Hue)

The effect of different ingredient and their combination on H* (Hue) colour value are given in (Table 1.). The H*(Hue) value varies from 75.05 and 86.49. The minimum and maximum value were recorded in Expt. 41 and 26 respectively, which represented the combination of ingredients to be 29:35g, 18g, 16g, 1.5g, 0.34g, 0.30. and 19:45g, 17g, 15g, 1.75g, 0.6g, 0.40g of WWF:QF, sugar, fat, SMP, ABC and baking powder, respectively.

The Analysis of variance table 3.indicates that, F-ratio (1.36) was lower as compared to table value 1.95. The R^2 value of perdition model was 60.53%. The finding indicates that model was found non-significant and could not explain more than 60.53% variability in the experiments. Hence, the model was not found adequate for further analysis. The present findings could not be confirmed due to availability of reported results.

Sensory characteristics of Whole wheat and quinoa flour biscuits

Colour and appearance score

The effect of different combination of ingredient on colour and appearance of whole wheat and quinoa flours biscuits given in Table 4 and presented through Fig.4.64 to 4.84. The sensory score for colour and appearance of biscuit minimum and maximum ranges from 5.50 to 8.50 score. The experiment number 26, 28, 32, represented the minimum and experiment number 25, 29, and 30 had a maximum score for colour and appearance of biscuits. These experiments had the combination of ingredients as 19:45g, 17g, 15g, 1.75g, 0.6g, 0.40g and 9:45g, 19g, 15g, 1.75g, 0.6g, 0.20g, and 19:45, 19g, 17g, 1.75g, 0.6g, 0.40g, and 39:25g, 17g, 15g, 1.75g, 0.6g, 0.20g and 39:25g, 17g, 17g, 1.75g, 0.6g, 0.40g and 19:45g, 17g, 17g, 1.75g, 0.6g 0.20g, of WWF:QF, sugar, fat, SMP, ABC and baking powder, respectively.

The ANOVA Table 6. indicates that F-ratio was significant. The F-ratio (3.01) was highest as compared to table value of 1.95. The R^2 value of perdition model was 77.21%. The finding indicates that model was significant and could explain less than 77.21% variability in the experiments. The model is considered adequate; therefore, further analysis has been carried out.

The results presented in Table 5. indicates that levels of quinoa flour have negative, while ammonium bicarbonate have positive linear significant effect on colour score of biscuit at 1 and 5 per cent level of significance respectively. All the interactive term of model was found non-significant. The result shows that levels of quinoa flour also exhibited positive quadratic significant effect at 1% level of significance. Rests of the terms of model were found non-significant. The lowest and highest sensory score of biscuits indicates that product is neither liked nor disliked and liked very much group. The linear and quadratic effect of quinoa flour and ammonium bi-carbonate was significant on colour score of biscuit. This is might be due to the fact that sucrose has been incorporated through quinoa flour. The findings of present investigation can be substantiated with the reports of Demir and Kilinc (2017) [7] and Thejasri *et al.*, (2017) [16].

4.2.2.2Texture score

The effect of different combination of ingredient on texture score of whole wheat and quinoa flours biscuits given in Table 4. and presented through Fig 4.85 to 4.105. The sensory score for texture of whole wheat and quinoa flours biscuits ranged from 4.50 and 8.00 in Expt. No 30, 34 and 25, 29, respectively. The experiments represents the combination of various ingredients *viz.* WWF:QF, sugar, fat, SMP, ABC, and baking powder, to be 19:45g, 17g, 17g, 1.75g, 0.6g, 0.20, and 13:34:50, 65, 18g, 16g, 1.5g, 0.5g, 0.30g, and39:25g, 17g, 15g, 1.75g, 0.6g, 0.20g, and39:25g, 17g, 17g, 1.75g, 0.6g, 0.40grespectively. The analysis of variance table 6. shows that model is found to be adequate because calculated value of F-ratio was higher than the F Table value at 5 per cent level of significance. The R^2 value and standard deviation of model were found to be 69 per cent and 0.67, respectively. The findings suggest that among the linear term, levels of quinoa flour shows negative significant effect at 1% level of significance. The interactive terms of model for interaction between quinoa flour-skimed milk powder, fat-skimmed milk powder were significant at 1% level of confidence. The quadratic effect of levels of quinoa flour was found significant at 1% level of confidence limit. The sensory score for texture of biscuit ranked as disliked slightly and liked very much group respectively. The findings suggest that the levels of quinoa flour and ammonium bicarbonate show positive significant effect. The interactions of various ingredients also contribute significant effect on texture of biscuit. The quadratic effect of levels of quinoa flour exhibits that texture can be further improved significantly. The results are in conformity with reports of Makpoul and Ibrahem (2015) [11] and Thejasri *et al.*,(2017) [16]

4.2.2.3 Crispiness score

The sensory score for Crispiness of whole wheat and quinoa flours biscuits is given in table 4.9. It was minimum 5.00 in Expt.no.30, 32, and maximum 8.50 in Expt.no.12, 17, 23, 25, 27, 29, 31 and 36. The analysis of variance Table 4.shows that F-ratio was higher than the F Table value at 5% level of significance. The R^2 value and standard deviation of model were found to be 75.73 per cent and 0.53, respectively. The model term was significant and adequate for further analysis. The findings suggest that among the linear and quadratic terms, the levels of quinoa flour show negative significant effect at 1% level of significance. The interactive terms of model for interaction between fat-skimmed milk powder were significantat 1% level of significance. The quadratic effect of levels of quinoa flour show significant effect at 1% level of significance. Rests all the terms of model were found non-significant. The sensory score for crispness of biscuit ranked between neither liked nor disliked and liked very much group respectively. The higher score of crispness is might be due to the fat that levels of quinoa flour imparts hard crust of biscuits at the same time fat and skimmed milk powder provide internal porous texture of biscuit which increases crispness score of biscuit. The results are in conformity with reports of Thejasri *et al.*, (2017) [16], Kamaliy and Subhash (2003), Shukla (1997) [3].

4.2.2.4 Taste score

The sensory score for taste of whole wheat and quinoa flours biscuits in given table 4.9. It was minimum 4.00 in Expt. 24, 26, 28, 30, 34, and maximum 8.50 in Expt.29. Table 4 indicates that F-ratio (6.66) for full second order regression model was higher than the F table value (1.95) at 5% level of significance. The R^2 value and standard deviation of model were found to be 88.22% and 0.97, respectively. The model was adequate hence further evaluated for linear, quadratic and interactive terms. The findings suggest that simple effect of levels of quinoa flour has significant effect at 1% level of significance on taste score of biscuits. The interactive effect of quinoa flour-skimmed milk powder, quinoa flour-ammonium bicarbonate was also observed significant at 1% level of confidence. The quadratic effect of levels of quinoa flour was found significant at 1% level of confidence limit. Rests all the terms of model were found non-significant. The present findings are in conformity with reported results of Thejasri *et al.*, (2017) [16].

4.2.2.5 Over all acceptability score

The effect of different combination of ingredient on overall acceptability of whole wheat and quinoa flours biscuits given in Table 4. and presented through Fig. 4.106 to 4.126. It varied from 4.87to 8.12 score. The experiment of minimum and maximum sensory score represents, Expt.No.34 and 29 respectively, and represent the following various combination of ingredients *viz.* WWF:QF, sugar, fat, SMP, ABC, and baking powder to be 13.34:50.65g, 18g, 16g, 1.5g, 0.5g, 0.30g and39:25g, 17g, 17g, 1.75g, 0.6g, 0.40g respectively. The analysis of variance (Table 4.11) of model indicates that F-ratio (4.43) was significant. The coefficients of determination (R^2) and standard deviation of model was 83.62 and 0.48 respectively. The probability value of regression model shows that linear effect of quinoa flour and its interaction with skimmed milk powder and ammonium bi carbonate has significant effect at 1 % level of confidence. Quadratic effect of levels of quinoa flour was also significant for overall acceptability score of biscuit. Rests all the terms of model were found non-significant.

The overall acceptability sensory score of biscuit is generally taken as summation of colour & appearance, texture, crispness, taste sensory score. In the present investigation panelist have given separate rating for overall acceptability of biscuit. The fitted model statistically not explains variability because of panelist results. The levels of sugars, fat, baking powder individually and interactively could not contribute significant effect to show the acceptance of product. The present findings can be supported by reported results of Nisar *etal.* (2018) [12].

Table 4: Sensory scores of whole wheat and quinoa flour biscuits

Exept. No	Colour and appearance	Texture	Crispiness	Taste	Overall acceptability
1	6.33	6.33	6.66	6.33	6.46
2	5.66	6.00	6.00	6.00	5.93
3	6.66	6.33	6.66	6.33	6.53
4	6.33	6.33	6.33	6.33	6.26
5	6.33	6.00	6.33	6.00	6.33
6	6.20	6.28	6.14	6.18	6.22
7	7.66	7.66	7.33	7.00	7.40
8	5.75	6.00	6.50	6.50	6.25
9	6.00	6.50	6.50	6.25	6.35
10	5.75	7.00	6.75	6.25	6.50
11	6.50	7.00	7.25	5.75	6.65
12	6.75	7.00	7.50	6.00	6.75
13	7.66	6.25	6.75	5.50	6.53
14	6.50	6.50	6.75	5.00	6.15
15	6.00	6.00	6.00	6.00	6.25
16	6.75	6.00	5.75	5.75	6.20
17	7.25	7.00	7.50	7.25	7.30
18	7.00	6.00	6.50	6.25	6.40
19	6.50	6.00	6.50	6.25	6.45
20	6.75	6.75	7.00	6.75	6.85
21	6.75	6.75	6.75	6.25	6.60
22	6.50	8.00	6.50	4.50	6.40
23	8.50	6.50	7.50	7.50	7.50
24	6.00	7.00	7.00	4.00	6.00
25	8.50	8.00	7.50	7.50	7.70
26	5.50	6.00	6.50	4.00	5.60
27	8.50	8.00	7.50	8.00	7.80
28	5.50	6.00	7.00	4.00	5.70
29	8.50	8.00	7.50	8.50	8.00
30	8.50	4.50	5.00	4.00	5.40
31	7.00	7.50	7.50	8.00	7.50
32	5.50	5.00	5.00	4.50	4.90
33	7.50	7.50	7.00	7.50	7.30
34	5.50	4.50	5.50	4.00	4.80
35	7.50	7.50	8.00	7.00	7.60
36	7.00	7.75	7.50	6.62	7.22
37	7.37	7.25	6.87	6.62	6.97
38	7.62	7.87	7.37	7.37	7.47
39	7.50	7.50	7.37	7.25	7.42
40	8.00	7.12	7.12	7.25	7.32
41	7.62	7.37	7.00	7.37	7.37
42	7.50	7.25	7.62	7.50	7.47
43	7.75	7.62	7.37	7.50	7.52
44	7.50	7.00	6.50	7.00	7.05
45	7.93	7.33	7.93	7.73	7.71
46	7.93	7.33	7.93	7.73	7.71
47	7.93	7.33	7.93	7.73	7.71
48	7.93	7.33	7.93	7.73	7.71
49	7.93	7.33	7.93	7.73	7.71
50	7.93	7.33	7.93	7.73	7.71
51	7.93	7.33	7.93	7.73	7.71
52	7.93	7.33	7.93	7.73	7.71

Table 5: Regression coefficient of full second order model and significant terms for sensory attributes score of whole wheat and quinoa flour biscuits

Coefficient	Colour and appearance	Texture	Crispiness	Taste	Overall acceptability
Constant	7.89	7.42	7.75	7.65	7.70
Linear					
$\beta_1 BX_1$	-0.4561***	-0.3836***	-0.3214***	-0.7555***	-0.4773***
β_2 BX_2	-0.0830	0.0095	0.0517	0.0625	0.0083
β_3 BX_3	0.1358	-0.0360	-0.1238	-0.0782	-0.0018
β_4 BX_4	0.1090	-0.0074	-0.0228	-0.1198	-0.078
β_5 BX_5	0.2638**	0.0984	0.1225	0.0077	0.1254
β_6 BX_6	-0.0724	0.0003	-0.0225	0.0802	-0.0059
Interactive					
$\beta_{1.2} BX_1X_2$	-0.0713	-0.0112	0.0372	0.0125	-0.0056
$\beta_{1.3}$ BX_1X_3	0.0094	-0.0406	-0.1416	-0.1950	-0.0944
$\beta_{1.4}$ BX_1X_4	-0.0663	-0.2825**	-0.0934	-0.3000***	-0.1881**
$\beta_{1.5}$ BX_1X_5	-0.2125	-0.2356	-0.1872	-0.6281***	-0.3181***
$\beta_{1.6}$ BX_1X_6	-0.1237	0.1031	0.0634	-0.0862	-0.0087
$\beta_{2.3}$ BX_2X_3	-0.1650	-0.0375	-0.0303	0.1169	-0.0262
$\beta_{2.4}$ BX_2X_4	-0.2044	-0.0144	-0.0684	-0.0281	-0.0762
$\beta_{2.5}$ BX_2X_5	-0.1944	-0.0925	-0.0059	-0.0438	-0.0812
$\beta_{2.6}$ BX_2X_6	0.2069	-0.1500	-0.0791	0.1644	0.0331
$\beta_{3.4}$ BX_3X_4	0.0687	-0.2875**	-0.2234**	0.0956	-0.0887
$\beta_{3.5}$ BX_3X_5	-0.0350	0.0406	-0.0359	-0.0450	-0.0212
$\beta_{3.6}$ BX_3X_6	-0.1125	-0.0269	-0.0253	-0.0031	-0.0406
$\beta_{4.5}$ BX_4X_5	0.0394	-0.0725	-0.0953	0.1225	-0.0037
$\beta_{4.6}$ BX_4X_6	-0.1106	0.0163	-0.0322	-0.0231	-0.0344
$\beta_{5.6}$ BX_5X_6	0.1494	0.1881	0.0616	0.1800	0.1481
Quadratic					
$\beta_{1.1} BX_1X_1$	-0.5452***	-0.6240***	-0.5303***	-0.7406***	-0.6314***
$\beta_{2.2}$ BX_2X_2	-0.2390	0.0394	0.0820	-0.3078	-0.1272
$\beta_{3.3}$ BX_3X_3	-0.1390	0.0129	-0.1752	-0.2323	-0.0537
$\beta_{4.4}$ BX_4X_4	-0.0349	-0.0892	-0.1241	-0.1282	-0.1150
$\beta_{5.5}$ BX_5X_5	-0.1124	-0.0892	-0.0976	-0.0527	-0.1089
$\beta_{6.6}$ BX_6X_6	-0.0859	-0.0892	-0.2507	-0.1282	-0.1579

***Significant at 1 %, **Significant at 5 %, BX_1-WWF: QF, BX_2-Sugar, BX_3-Fat, BX_4-Skimmed milk powder (SMP), BX_5-Amonoum bicarbonate (ABC), BX_6-Baking powder (BP).

Table 6: ANOVA for best fit regression model of sensory properties of whole wheat and quinoa flour biscuits

Source	Colour and appearance	Texture	Crispiness	Taste	Overall acceptability
Model S.S.	33.10	24.72	21.63	65.94	29.07
Model MS.	1.23	0.9195	0.8010	2.44	1.08
Model DF	27	27	27	27	27
Error S.S.	9.77	10.83	6.93	8.80	5.70
Error MS	0.4071	0.4513	0.2889	0.3667	0.2374
Error DF	24	24	24	24	24
F Ratio	3.01	2.03	2.77	6.66	4.54
F Table	1.95	1.95	1.95	1.95	1.95
R Square %	77.21	69.53	75.73	88.22	83.62
Std. dev.	0.6381	0.6718	0.5375	0.6056	0.4872
Mean	7.07	6.83	6.97	6.52	6.85
C.V.%	9.03	9.84	7.71	9.28	7.11

Conclusion

From the present investigation it could be concluded that quinoa flour is good alternative to Maida and also provide good quality texture and sensory properties moreover its best alternative for peoples with celiac disease so quinoa has bright future over Maida in bakery products and at present investigation it was found that 25% quinoa flour is best treatment for as textural as well as sensory point of view.

References

1. ACCC. Approved method of analysis. The American Association of Cereal Chemist. St. paul Minnesota, 1984.
2. AOAC. Official methods of analysis 15th edition. Association of Official Analytical Chemists, Washington, D.C, 1990, 113-127.
3. Bhargava A, Shukla S, Ohri D. Genetic variability and heritability of selected traits during different cuttings of vegetable Chenopodium. Indian Journal Genetic Plant Breeding. 2003; 63:359-360.
4. Bourne, M. 2002. Food Texture and Viscosity, Concept and Measurement, Academic. New York, 2002, 353-368.
5. Chauhan GS, Zillman RR, Eskin NAM. Dough mixing and bread making properties of quinoa-wheat flour blends. International Journal of Food Science and Technology. 1992; 27(1):701-705.
6. Chauhan GS, Zillman RR, Eskin NAM. Dough mixing and bread making properties of quinoa-wheat flour blends. International Journal of Food Science and Technology. 1992; 27(1):701-705.
7. Demir Mk, Kilinc M. Utilization of quinoa flour in cookie production. International Food Research Journal. 2017; 24(6):2394-2401.
8. Finney KF, Morris VH, Yamazaki WT. Micro versus macro cookie baking procedures for evaluating the cookie quality of wheat varieties. Cereal Chemistry. 1950; 27:42-49.
9. Haridas Rao P, Rahim A, Prabhavathi C, Shurpalekar SR. Physic-chemical, rheological and milling characteristics of Indian durum wheats. Journal Food Science. Technology. 1976; 13(11):317-322.
10. Hoojjat P, Zabik ME. Sugar-snap cookies prepared with wheat-navy bean-sesame seed flour blends. Cereal Chem. 1984; 61(1):41-44.
11. Makpoul KR, Ibrahem AA. Improving biscuit Nutritional value using quinoa flour, Journal Food and Dairy Science. Missouri University. 2015; 6(12):771-780.
12. Nisar M, More DR, Syed Z, Sawate AR, Hashmi SI. Studies on Development of Technology for Preparation of Cookies incorporated with Quinoa seed flour and its Nutritional and Sensory quality evaluation, International Journal of Chemical Studies. 2018; 6(2):3380-3384.
13. Raghuramulu, N, Nair MK, Kalyanasundaram S. A Manual of Laboratory Technique. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India, 1993, 69-72.
14. Ruales J, Nair BM. Effect of processing on the digestibility of protein and availability of starch in quinoa (*Chenopodium quinoa willd*) seeds. Department of Applied Nutrition, University of Lund, Sweeden. EscualaPolitécnica Nacional. Quito, Ecuador, 1992, 23.
15. Singh B, Bajaj M, Kaur A, Sharma S, Sindhu J. Studies on development of high protein biscuits from composite flours. Plant Foods Human Nutrition... 1993; 43(2):181-189.
16. Thejasri V, Hymavathi TV, Pradeepa Roberts TP, Anusha B, Suchiritha Devi S. Sensory, Physico-Chemical and Nutritional Properties of Gluten Free Biscuits Formulated with Quinoa, Foxtail Millet and Hydrocolloids. International Journal of Current Microbiology and Applied Sciences. 2017; 6(8):1710-1712.