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Physical and Textural Properties of Gluten Free Biscuits Containing Rice Flour, Soya Flour and Buckwheat Flour

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ABSTRACT

Background: Gluten free biscuits are at high demand at present which is suitable for celiac patient. Many changes takes place during the preparation of biscuit may be due to ingredients used or baking process. Therefore, this research was conducted to evaluate the physical and textural properties of gluten free biscuit containing rice flour, soya flour and buckwheat flour.

Methods: The experiment was carried out during the period from January, 2018 to April, 2018. Gluten free biscuits were prepared from composite flours of two varieties of rice flours, soya flour and buckwheat flour. The physical and textural properties were investigated using standard procedures.

Result: Due to addition of buckwheat flour and soya flour weight and hardness of the developed biscuit was increased and diameter, thickness was decreased. Colour tends to redness and yellowness. This is due to addition of soya flour and buckwheat flour in other treatments. Therefore, gluten free biscuit can be prepared by using rice flour, soya flour and buckwheat flour with good physical and textural properties.

Key words: Biscuits, Gluten free, Physical, Rice flour, Textural.

INTRODUCTION

Nowadays food choices of consumers are more diverse. Inclusion of processed and value added products in their food baskets are increasing day by day.

Out of all, biscuit is one of the oldest and prominent bakery item which is in high demand consumed by all age groups, globally (Masoodi *et al*., 2012). Wheat flour is used as a base ingredient for preparing biscuit which cannot be taken by people with celiac disease is emerging to utilize composite flour in biscuit manufacturing (Kiin-Kabari and Giami, 2015).

However, gluten must be restricted from the diet of celiac patient as it exerts serious damage in the intestinal villi. At present 40-60 million people were affected globally. Celiac disease is reported as common in few Asian countries like India, China, Pakistan and Middle Eastern countries (Mohta *et al*., 2021). So, there is a need of hour to work in the development of gluten free food products sector. Composite flour of all gluten free food sources like rice flour, soya flour, buckwheat flour are desirable for preparation of gluten-free biscuit (Nedeljkovic *et al*., 2013). Rice is gluten free and apart from carbohydrate and protein, it contains other nutrients like calcium, copper, iron, magnesium, manganese, niacin, riboflavin, *etc*. It has low prolamin, hypoallergenic activity, low sodium and high digestible carbohydrate contents which is suitable for celiac diet (Mona *et al*., 2015). Soyabean is rich in calcium, phosphorus and vitamins A, B, C and D (Islam *et al*., 2007). Moreover, calcium absorption from soyabean is similar with milk, therefore, early bone disease caused due to malabsorption in celiac patient will be beneficial (Heaney *et al*., 1991). The use of buckwheat flour is desirable due to its content like starch and dietary fibre, essential minerals and trace elements, antioxidant activity and phenolic compounds like rutin, hyperin, orientin, quercetin, vitexin, isovitexin, isoorientin, kaempferol-3-rutinoside and catechins (Skrabanja *et al*., 2004; Dietrych Szostak and Oleszek, 1999).

Therefore, present investigation was carried out to prepare a gluten free biscuit by using rice flour, soya flour and buckwheat flour and evaluate some physical and textural properties.

MATERIALS AND METHODS

The present investigation was conducted in Department of Food Science and Nutrition, Assam Agricultural University, Jorhat, Assam during the period of January, 2018 to April, 2018. Two varieties of rice namely, V_1 (*Bahadur*) and V_2 (*Aghuni bora*) *i.e*. a non waxy grain collected from local market of Jorhat town and a waxy grain collected from Regional Agricultural Research Station (RARS), Titabor, Jorhat respectively. Buckwheat was collected from Gosaigaon, Krishi Vigyan Kendra (KVK), Kokrajhar. Soya flour and other ingredients required for preparation of biscuits were bought

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from local market. Ingredients *i.e*. two varieties of rice and buckwheat were processed into flour in order to use them as base ingredient for preparing of biscuits.

Preparation of biscuit

The biscuit was prepared from flour mix prepared by mixing two varieties of rice flours, buckwheat flour, soya flour at different ratio. Five different ratios are 50:50:0:0, 60:10:20:10, 50:20:20:10, 40:30:20:10, 30:40:20:10 respectively (Table 1) and were used to prepare 100 g flour mix for biscuit. The ratio of 50:50:0:0 of both waxy and non waxy rice flour was kept as control sample. The biscuits were prepared by traditional creaming method (Mishra *et al*., 2015). Creaming was done by mixing margarine, powdered sugar, egg and vanilla essence. Flours were added with baking powder and salt into the cream and made into a dough. The dough was rolled out into a sheet using a rolling pin and cut into desired shape using a cutter and subjected to baking in an oven at 180°C for 15 minutes. List of ingredients were given in Table 2.

Physical parameters

Diameter of biscuit was measured by laying six biscuits edge to edge with the help of a scale rotating the biscuits 90° and again measuring the diameter of six biscuits in cm and then taking average value (AOAC, 2000).Thickness was measured by staking six biscuits on the top of each other and taking average thickness in cm (AOAC, 2000). Weight of the biscuits was measured as average of values of four individual biscuits with the help of digital weighing balance (Man *et al*., 2014). Spread ratio was calculated by dividing the average value of diameter by average value of thickness of biscuits (AOAC, 2000).

Table 1: Treatment description of gluten free biscuits.

Treatment	Non waxy rice flour %	Waxy rice flour %	Buckwheat flour %	Soya flour %
T_1 (control)	50	50	-	-
T_2	60	10	20	10
T_3	50	20	20	10
T_4	40	30	20	10
T_5	30	40	20	10

T_1= 50:50, (NW:W); T_2= 60:10:20:10, (NW:W:BF:SF); T_3= 50:20:20:10, (NW:W:BF:SF); T_4= 40:30:20:10, (NW:W:BF:SF); T_5= 30:40:20:10, (NW:W:BF:SF).

NW= Non waxy rice, W= Waxy rice, BF= Buckwheat flour, SF= Soya flour.

CIE' color parameters

CIE L*a*b* values of prepared rice based biscuits were determined by Hunter Lab Colour Quest XE Colorimeter (Hunter Associates Laboratory, Inc., Virginia, USA) and Hue and Chroma values were calculated by the following equations (Saikia, 1999):

- Hue = Tan^{-1} b/a
- Chroma = $\sqrt{a^2+b^2}$

Texture profile analysis

Biscuit hardness was measured using a TA. XT Plus texture analyzer (Stable Micro Systems, Great Britain) equipped with knife edge with slotted insert (HDP/BS) using a 5 kg load cell and heavy duty platform.The test speed was set to 3.0 mm/s and trigger force was automatic at 50 g. Maximum force was recorded as the hardness value (Oksuz and karakas, 2016).

Statistical analysis

Data obtained from the different nutritional and physical composition of biscuits were subjected to simple completely randomized design to determine differences between treatment means by using Microsoft excel (2007). The significance of treatment difference was tested by F-test at 5% probability level. The means were separated using the Duncan's multiple range test (DMRT) (Snecedor and Cochran, 1980).

RESULTS AND DISCUSSION

Physical properties of biscuit

Studies of physical properties are very important for baked products. Since consumer choice and preferences for various bakery products are expanding, the food industry increasingly depends upon ingredient which imparts good functional properties along with nutritional qualities.

Table 2: List of ingredients used in the preparation of biscuits.

Ingredients	T_1 (control)	T_2	T_3	T_4	T_5
Non waxy rice flour (g)	50	60	50	40	30
Waxy rice flour (g)	50	10	20	30	40
Buckwheat flour (g)	-	20	20	20	20
Soya flour (g)	-	10	10	10	10
Egg (g)	10	10	10	10	10
Sugar powder (g)	40	40	40	40	40
Margarine (g)	50	50	50	50	50
Baking powder (g)	2	2	2	2	2
Vanilla essence (ml)	2	2	2	2	2
Salt (g)	1	1	1	1	1

Table 3: Physical analysis of gluten free biscuits.

Criteria	Treatments						
	T_1 (Control)	T_2	T_3	T_4	T_5	$CD_{(0.05)}$	S.Ed
Diameter (cm)	3.84	3.80	3.81	3.80	3.81	NS	NS
Thickness (cm)	0.87^a	0.76^b	0.79^b	0.77^b	0.78^b	0.04	0.02
Weight (g)/biscuit	6.10^c	8.00^a	7.20^b	8.00^a	7.06^b	0.20	0.14
Spread ratio (cm)	4.40^b	5.00^a	4.80^a	4.90^a	4.88^a	0.30	0.20

Means in the same row with the different superscript are significantly different ($p<0.05$).

T_1= 50:50, (NW:W); T_2 = 60:10:20:10, (NW:W:BF:SF); T_3= 50:20:20:10, (NW:W:BF:SF); T_4= 40:30:20:10, (NW:W:BF:SF); T_5= 30:40:20:10, (NW:W:BF:SF).

NW= Non waxy rice, W= Waxy rice, BF= Buckwheat flour, SF= Soya flour.

The analysis on physical characteristics of developed rice based biscuits is presented in Table 3.

Diameter

The diameter of rice based biscuits ranged from 3.80 to 3.84 cm. In control biscuit diameter was 3.84 cm and diameter reduced to 3.80 cm in T_2, 3.81 cm in T_3, 3.80 cm in T_4, 3.81 cm in T_5. The reduction in diameter may be due to high fibre content of developed biscuits which absorbs water and thereby reduce in expansion of diameter of the biscuits as compared to control biscuits (Baljeet *et al*., 2010), however reduction of diameter of developed gluten free biscuits was found to be statistically non significant at $P<0.05$. Baljeet *et al*. (2010) reported that expansion in diameter decreases due to addition of buckwheat flour in biscuit which may be due to increased fibre content in biscuits.

Thickness

From Table 3 it is evident that the thickness of control biscuit was much higher (0.87cm) in comparison to all other treatments. The thickness of other treatments ranged from 0.76 to 0.79 cm. Different levels of incorporation of rice flours shows statistically significant effect on the thickness. It might be contributed by the fibre in the biscuit formulation which decreased the thickness of biscuit. Studies observed the reduced expansion of thickness with addition of fibre containing ingredients in developed biscuits (Mridula *et al*., 2009; Mridula, 2011). Several studies also indicate that crude fibre of the biscuit formulations reduces the thickness development during cooking (Brennam and Samyue, 2004; Mridula *et al*., 2007).

Weight

The weight of control biscuit was recorded to be 6.1 g which was found lower than all other treatments. Weight of biscuits of other treatments ranged from 7.06 g to 8.0 g. There is a nominal increase in the weight of other treatments in comparison to weights of the samples T_2 and T_4, T_3 and T_5 was observed. Man *et al*. (2014) reported that biscuits developed by mixing of different flours with rice flour increases the weight which ranged between 8.4 g to 8.2 g in T_1 - 33.33:33.33:33.33; T_2 - 32:42:26; T_3 - 30:30:40; T_4 - 26:37:37 of composite flour (maize flour, rice flour, soybean flour respectively).

Spread ratio

The changes in diameter and thickness of biscuits are reflected in the spread ratio of biscuits. It is found to be increased on incorporation of composite flours when compared to control biscuit. Sample T_2, T_3, T_4 and T_5 has no significant difference among the treatments which ranged from 4.80 cm to 5.0 cm. The increasement in spread ratio of the biscuits in comparison to control biscuit is significant by different at $P<0.05$. The increase in spread ratio might be due to addition of soyabean flour and buckwheat flour which are rich in protein and fibre which has high water binding power. Increasement also may be due to decrease in thickness of biscuit developed. Giwa and Victor (2010) reported that spread ratio increased with the increasing level of substitution with quality protein maize. The inclusion of quality protein maize flour enhanced the spreadability of the biscuit samples which reduced with the level of replacement with quality protein maize.

CIE' color parameters

Colour is one of the most important quality factors of bakery products and appetite is stimulated by colour perceived by the consumer. The colour values as measured in Hunter Lab Color Quest XE colorimeter for developed biscuit are presented in Table 4. The colour scores of developed gluten free biscuits for all the treatment showed almost similar. Developed biscuit *i.e*. control sample scores colour value as 63.25 L* measurement indicates light colour of the biscuit, 7.70 a* measurement indicates towards redness and 20.44b* measurement towards yellowness, 21.88 Hue and 11.32 chroma. Treatment T_2 scores lightness value was 62.73, redness value 7.84, yellowness value was 20.47 with Hue 21.92 and chroma 11.12. The lightness value of treatment T_3 was 63.44, redness value was 7.63, yellowness value was 20.45 along with hue 21.82 and chroma 11.42. The lightness value of T_4 was 63.47, redness value was 7.63, yellowness value was 20.53 with hue 21.9 and chroma 11.43. Treatment T_5 scores lightness value was 63.45, redness value was 7.64, yellowness value was 20.46 with hue 21.83 and chroma 11.41. No vast difference was observed between control and other treatments. Divyashree *et al.* (2016) reported that L* indicates the whiteness of the

Table 4: CIE' Color parameters of biscuits.

Treatments	CIE' Color parameters				
	L*	a*	b*	Hue	Chroma (C*)
T_1	63.25±0.46	7.70±0.12	20.44±0.04	21.88±0.03	11.32±0.05
T_2	62.73±0.41	7.84±0.10	20.47±0.02	21.92±0.02	11.12±0.02
T_3	63.44±0.43	7.63±0.14	20.45±0.04	21.82±0.02	11.42±0.08
T_4	63.47±0.45	7.63±0.12	20.53±0.06	21.90±0.01	11.43±0.06
T_5	63.45±0.46	7.64±0.15	20.46±.02	21.83±0.03	11.41±0.02

Values are means of triplicate determinations±SD.

Notes on surface colour measurements.

L* Indicates lightness or darkness (0= black, 100= white); a* Indicates the hue on the green-to-red axis (negative value = Greenness, positive value = redness); b* Indicates the hue on the blue-to-yellow axis (negative value = Blueness, positive value = Yellowness); c* Is the intensity of the hue [C* = a*2 + b*2] and hue angle (H°) is the angle in the colour wheel of 360° (H° = tan-1 × b/a)

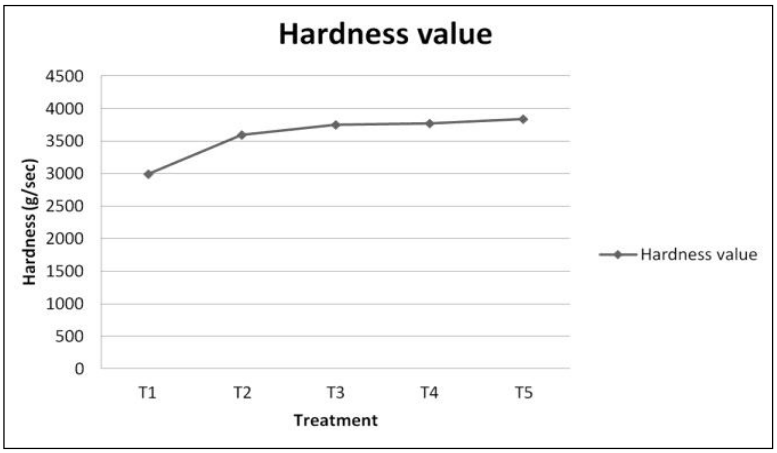

Fig 1: Hardness values of gluten free biscuit.

biscuits decreased from 68.41 in the control biscuits to 51.24 with the addition of 30 per cent buckwheat flour and 20 per cent chia seed flour.

Texture profile analysis

Biscuit hardness values are presented in Fig 1. Hardness values were recorded as the peak force applied to break the biscuits. Data showed that sample T_1, T_2, T_3, T_4 and T_5 had hardness values of 2994.3 g, 3598.3 g, 3750 g, 3773 g and 3838 g respectively. The formulation containing buckwheat flour, soyaflour and two varieties of rice flours resulted biscuits with significantly ($p<0.05$) harder texture than control biscuit which contains only rice flours. This increase is due to effect of buckwheat flour and soyaflour. Lee and Beuchat (1991) reported that more strength was needed to break cookies incorporated with legumes flour. This might have resulted from incorporation of protein rich flour which tends to be a biscuit of harder texture. In the present study, incorporation of soyabean flour might contribute towards hardness. According to Collar *et al*. (2007), addition of fibers affected the mechanical properties like increased hardness of dough. Presence of fibre in buckwheat may be responsible.

CONCLUSION

The physical and textural properties of prepared gluten free biscuit from rice flour, soya flour and buckwheat flour were investigated. Different ratios of two varieties of rice flours, soya flour and buckwheat flour had a significant effect at $p<0.05$. Due to addition of soya flour and buckwheat flour decrease in thickness, increase in weight was found. Colour tends to redness and yellowness while hardness increased with addition of buckwheat flour and soya flour parameters.

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