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Formulation and Standardization of Self Rising Flour as a Convenience Food Article for Preparation of High Quality Cookies

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Abstract

Convenience foods are fetching more consumer acceptance and have great market demand as they assist in ease of preparation, processing, handling and consumption. Bakery products, one of the convenience foods, usually encounters problem in selecting appropriate type and quantity of leavening agent to enable high quality product. Hence this investigation was undertaken to formulate and standardize the self rising flour by varying the level of different leavening agents such as sodium bicarbonate, potassium bicarbonate and ammonium bicarbonate and its effect on quality of cookies was assessed. Results have shown that addition of leavening agent at varying level did not alter the composition of wheat flour significantly. It was found that cookies prepared with 1.10 per cent sodium bicarbonate and 1.4 per cent acid calcium phosphate has the best quality in terms of spread factor, top grain and sensory characteristics. Significant variation was found on quality of cookies amongst the different leaving agents when used at varying levels.

Keywords: Self rising flour, leavening agent, cookies, convenience foods, quality.

Introduction

Convenience foods are described as problem free preparation and consumption of variety products. Food products that save time and effort in preparation, consumption, or cleanup are omnipresent. Many people's lifestyles today have led to a great demand for such convenience food products[1]. Convenience food as defined by Traub and Odland[2] as "any fully or partially prepared foods in which significant preparation time, culinary skills, or energy inputs have transferred from home kitchen to food processor or distributor"

Saving time by using convenience products is the most obvious aspect of convenience, and much research has considered the element of time. However, researchers have recognized that convenience involves more than just saving time and includes minimizing physical and mental effort associated with planning and preparing meals[3]. There is a general preference and growing trends towards these foods which also include baked products. Bakery products have now become an essential food item of the vast majority of the population. The basic raw material for bakery products is wheat. Out of all cereals, wheat occupies a unique place, being least expensive cereal available for creating convenient foods high in nutrition[4].

Leavening is the method which aerates a dough or batter during mixing and baking, by introducing bubbles of gas through mechanical forces or due to biochemical or chemical reactions. During the baking process, the bubbles expand, rise, allowing the final product to become light and porous in texture[5]. When there is lack of leavening, products remain flat with a dense crumb, and with inadequate distribution of moisture[6]. The most frequently used chemical leavening method involves the reaction of leavening base with an acid. In the presence of moisture and heat, it produces carbon dioxide at a controlled rate. The gas evolution starts during dough mixing, and continues through proofing and baking[5,7]. The timing of the release of CO_2 is critical in establishing uniform cell structure. Upon heating, the CO_2 will release and expand, resulting in the increased volume and desirable texture characteristic of good tasting, high quality baked goods[8]. Several carbon dioxide carriers are used in baked goods. The three bicarbonates used as leavening bases are sodium bicarbonate ($NaHCO_3$), potassium bicarbonate ($KHCO_3$), and ammonium bicarbonate (NH_4HCO_3). Potassium and calcium carbonates (K_2CO_3 and $CaCO_3$) are also used[6].

Self rising flour provides a great convenience for house hold use. Their use saves time and energy to eliminate the hardships of measuring out and provide desirable quality to product. Self rising flour contains bicarbonate, together with an acid ingredient, when made into a dough and baked, CO_2 is generated which causes dough aeration and development. Use of bicarbonate provides the favorable effects on the flavour, texture and colour of the finished bakery products due to caramelization.

Today's health conscious consumer demands convenience and nutritious products. Ready mixes for variety of foods can be seen in market, which offer convenience and quality to consumer for finished product. Though, the variety of ready mixes for bakery items are available but being costlier and less

stable at room temperature, there is an ample scope to introduce self rising flour in the market. Hence in the present investigation, attempt has been made to formulate and standardize the self rising flour and evaluate its performance by assessing the quality of cookies, one of the bakery products, prepared by utilizing self rising flour.

Materials and Methods

Materials: Wheat flour, chemical leavening agents (viz., sodium bicarbonate, potassium bicarbonate, ammonium bicarbonate, acid calcium phosphate, etc.), fat, sugar, eggs, salt, skim milk powder, packaging material, etc are purchased from the local market of Ludhiana, India.

Methods: Preparation of self rising flour: Ready to use self rising flour was prepared by adding three different leavening agents viz., sodium bicarbonate, potassium bicarbonate and ammonium bicarbonate at level of 1.0-1.25 per cent with acid calcium phosphate (ACP) at two different levels, 1.4 and 1.5 percent. The flour was sifted with requisite quantities of leavening agent and was gently mixed to obtain uniform distribution of leavening agents through entire wheat flour. The levels of leavening agents were decided based on preliminary trials.

Chemical composition: Wheat flour and self rising flour were studied for various chemical characteristics such as per cent starch, protein, fat, total sugars, pH, acidity and falling number (sec) by the standard procedure[9].

Product Preparation: Cookies were prepared in accordance with the standard procedures. The detailed ingredient formulation used to prepare cookies is given in table-1. The cookie dough was sheeted to a thickness of 0.5 cm and cut using a circular die of 6.5 cm diameter. Cookies were baked at 205 ^{0}C. After baking, the cookies were cooled to ambient room temperature (25±2^{0}C), wrapped in butter paper and then packed in low density (0.918 g/cm^3) polyethylene until used for evaluation.

Table-1
Recipe for preparation of cookies

Ingredients	Amount
Flour	90 g
Shortenings	25.6 g
Sugar	52.0 g
Salt (U.S.P.)	0.84 g
Leavening agent	As described in self rinsing flour preparation
Dextrose solution	13.2 ml
Distilled water	64 ml

Evaluation of Product Quality: Spread ratio (W/T): The diameter (*D*) and thickness (*T*) of the cookie samples were measured using a vernier caliper and average value is reported. Spread ratio (*S*) was estimated by calculating *D*/*T* values[9].

Top grain: Top grain in cookies was evaluated as per the method described by Vratanine and Zabik[10].

Overall acceptability: In order to evaluate the differences between various cookies formulations, sensory assessment was performed. Sensory characteristics such as color, flavor, taste, texture and overall acceptability was accessed by using semi trained panel member (n=5) on the 9-point hedonic scale[11].

Statistical analysis: All the experiments were replicated, so that the data in the paper represent the mean values of three tests. The coefficient of variation (CV) of all the tests was lower than 10 per cent.

Data was analyzed by one-way analysis of variance. This was followed by a multiple comparison test (least significant difference – LSD) to assess whether each level of a parameter was significantly ($p \leq 0.05$) different from the other level[12] The data analysis was carried out using SPSS 16.0.1 (SPSS Inc., Chicago, IL, USA).

Results and Discussion

Chemical composition: The chemical composition of wheat flour and self raising flour is presented in table-2. The wheat flour contained 9.23 per cent protein, 0.82 per cent fat, 64.90 per cent starch and 5.08 per cent total free sugars. The acidity and pH of the wheat flour were 0.17 per cent and 5.85 respectively while the falling number was 372 sec.

Table-2
Chemical characteristics of wheat flour and self rising flour[#]

Chemical Characteristics	Wheat flour	Self rising flour
Protein (%)	9.23	9.15
Fat (%)	0.82	0.81
Starch (%)	64.90	65.20
Total sugars (% glucose)	5.08	5.11
Ash (%)	0.49	0.50
Acidity (%)	0.17	0.12
pH	5.85	7.05
Falling Number (sec)	372	368

[#] prepared with 1.10 per cent sodium bicarbonate and 1.4 per cent acid calcium phosphate

No significant difference was observed in the chemical composition of self rising flour prepared with 1.10 per cent sodium bicarbonate and 1.4 per cent acid calcium phosphate in comparison to wheat flour except pH and acidity. The acidity of self rising flour was dropped sharply and thus elevating the pH. This could be due to the basic nature of leavening agents added in the flour.

Effect of self rising flour containing different levels of

sodium bicarbonate: Effect of different levels of sodium bicarbonate with acid calcium phosphate is depicted in table-3. The results obtained indicated that with incremental addition of sodium bicarbonate the spread ratio (W/T) also increased. The highest value of spread ratio was obtained at 1.10 per cent sodium bicarbonate with 1.4 per cent acid calcium phosphate. Further addition of sodium bicarbonate reduced the spread ratio in cookies. However, it was observed that the effect of sodium bicarbonate with 1.4 per cent ACP on cookies spread ration was non-significant, though 1.5 per cent ACP with sodium bicarbonate showed significant effects ($p \leq 0.05$). Similar trend was observed for top grain. Top grain measures the uniformity of the cracks on the surface of cookies. Flour sample containing 1.10 per cent sodium bicarbonate and 1.5 per cent ACP, showed the cookies with uniform cracks, having top grain value 3.30. Alike spread ratio, the value of top grain also decreased when concentration of sodium bicarbonate in wheat flour was increased. Top grain of cookies was significantly influenced by both levels of ACP (1.4 and 1.5 per cent) with sodium bicarbonate. Overall acceptability which was the mean of different sensory attributes, was higher for cookies prepared with 1.10 per cent sodium bicarbonate and 1.4 per cent ACP because of better colour, taste and flavour. The highest value of overall acceptability was 7.28 with 1.10 per cent sodium bicarbonate and 1.4 per cent ACP.

With the same level of sodium bicarbonate, incremental addition of ACP beyond 1.4 per cent resulted in decreased quality of cookies. This may be due to the excess acidity conferred by the ACP which suppressed spread ratio, top grain and hence overall acceptability of the cookies.

Effect of self rising flour containing different levels of potassium bicarbonate: The results of effect of different levels of potassium bicarbonate are presented in table-4. Spread ratio of cookies prepared with different levels of potassium bicarbonate and 1.4 per cent ACP ranged between 1.13 to 1.23, the highest value was obtained at 1.10 per cent potassium bicarbonate. Additional potassium bicarbonate reduced the spread ratio of cookies, similar to effect of sodium bicarbonate. However, unlike sodium bicarbonate, the potassium bicarbonate with 1.4 and 1.5 per cent ACP produced significant ($p \leq 0.05$) results. Top grain of cookies prepared with potassium bicarbonate also followed the same trend as that of cookies prepared with sodium bicarbonate. The top grain of cookies was significantly improved from 2.40 to 3.00 when the quantity of potassium bicarbonate increased from 1.05 to 1.10 per cent in the flour. Top grain value, again, did not improved by further addition of potassium bicarbonate. Among all levels of potassium bicarbonate, acceptability score and sensory parameters like colour, texture, taste and flavour were better for cookie containing 1.10 per cent potassium bicarbonate as leavening agent which contributed to the higher acceptability score.

Table-3
Effect of self rising flour containing different level of sodium bicarbonate on quality of cookies

Leavening Agent	**$NaHCO_3$* +1.5% ACP#**			**$NaHCO_3$+1.4% ACP**		
Level/ Quality Aspect	**W/T**	**Top Grain**	**Overall Acceptability**	**W/T**	**Top Grain**	**Overall Acceptability**
1.00	1.13	2.70	6.47	1.21	2.80	6.84
1.05	1.15	2.70	6.65	1.22	2.85	6.93
1.10	1.24	3.30	7.13	1.26	3.40	7.28
1.15	1.23	2.75	7.01	1.25	3.30	7.19
1.20	1.20	2.75	6.89	1.24	3.25	7.11
1.25	1.18	2.70	6.70	1.24	3.00	7.01
LSD ($p \leq 0.05$)	0.032	0.28	0.14	NS	0.25	0.043

* Sodium bicarbonate, # Acid calcium phosphate

Table-4
Effect of self rising flour containing different level of potassium bicarbonate on quality of cookies

Leavening Agent	**$KHCO_3$* +1.5% ACP#**			**$KHCO_3$+ 1.4% ACP**		
Level/ Quality Aspect	**W/T**	**Top Grain**	**Overall Acceptability**	**W/T**	**Top Grain**	**Overall Acceptability**
1.00	1.13	2.30	6.19	1.18	2.75	6.81
1.05	1.13	2.40	6.38	1.19	3.80	6.88
1.10	1.23	3.00	7.08	1.24	3.30	7.20
1.15	1.20	2.75	6.94	1.23	3.25	7.14
1.20	1.18	2.50	6.78	1.21	3.20	7.08
1.25	1.15	2.50	6.66	1.20	3.00	6.99
LSD ($p \leq 0.05$)	0.035	0.24	0.031	0.032	0.35	0.14

* Sodium bicarbonate, # Acid calcium phosphate

In case of cookies with 1.4 per cent ACP, there were significant improvements observed among spread ratio and top score upto 1.10 per cent level of potassium bicarbonate, further these attributes were slightly less at higher levels of potassium bicarbonate. Mean value of overall acceptability score was significantly higher at 1.10 per cent level of potassium bicarbonate and 1.4 per cent ACP as mean values of colour (7.25), texture (7.10), were significantly higher corresponding to this level. With potassium bicarbonate too, the ACP addition beyond 1.4 per cent did not improved the quality of cookies suggesting that potassium bicarbonate and sodium bicarbonate had more or less same effect with ACP on the quality of cookies.

Effect of self rising flour containing different levels of ammonium bicarbonate: The perusal of data given in table-5 depicts that spread ratio (W/T) was initially increased significantly ($p \leq 0.05$) up to 1.10 per cent level of ammonium bicarbonate with 1.4 and 1.5 per cent ACP, however, further addition of ammonium bicarbonate lowered the value of spread ratio. The spread ratio was significantly affected by varying the level of ammonium carbonate along with 1.4 per cent ACP but not with the 1.5 per cent ACP. It suggests that addition of ACP beyond 1.4 per cent did not result in significant improvement of cookies spread factor. The width and thickness ratio was maximum at 1.10 per cent level followed by 1.15 per cent of ammonium bicarbonate. Different level of ammonium bicarbonate as well as ACP in self raising flour had significant impact on the top grain of cookies. Influence of ammonium bicarbonate and ACP on top grain followed the same pattern as that of spread factor of cookies. The top grain of cookies increased by increasing the level of ammonium bicarbonate up to 1.10 per cent beyond which it decreased again. Cookies containing ammonium bicarbonate as leavening agent resulted in better top cracks which contributed to higher score at higher levels. The highest mean overall acceptability score was found at 1.10 per cent of ammonium bicarbonate at both the levels of ACP (1.4 and 1.5%). On the other hand the overall acceptability score reduced in comparison to other leavening agents. The reason for less acceptability was presence of black specks on cookie top and a bit better taste of cookies. Ammonium bicarbonate in combination with 1.4 per cent ACP resulted in better cookie quality with better cookie top grain score at 1.10 per cent level (3.30) and acceptability score (7.19) than the ACP at 1.5% level. Better acceptability was due to better texture i.e. crispiness of cookies.

Conn[13] also reported that ammonium bicarbonate can be used in some cookies and crackers applications. However, its application in moist, large-volume bakery products is not feasible as ammonium bicarbonate tends to produce a objectionable flavour.

Conclusion

Self rising flour was prepared by using different leavening agents at different levels. The effect of this self rising flour on product quality was evaluated. The quality of cookies was significantly better at 1.10 per cent level of sodium bicarbonate as leavening agent as inferred from product characteristics. The quality of product was better when level of ACP was 1.4 per cent, at same level of sodium bicarbonate as compared to 1.5 per cent ACP. Similarly, baked product viz., cookie prepared by using different levels of potassium bicarbonate, had better quality at 1.10 per cent level and 1.4 per cent ACP. Significantly quality improved cookies were obtained at 1.10 per cent level of ammonium bicarbonate and 1.4 per cent ACP level as compared to 1.5 per cent ACP and same level of potassium bicarbonate. In case of ammonium bicarbonate, prepared product appeared best, but black specks on cookie top and unpleasant flavour was noticed.

As seen from product quality, sodium bicarbonate (1.10%) and ACP (1.4%) were best for the preparation of self rising flour. The standardized level (1.10% sodium bicarbonate and 1.4% ACP) of leavening agents for self rising flour was compared with existing prescribed composition of self rising flour (1.16% sodium bicarbonate and 1.61% ACP). Non significant variations were observed in the quality parameters of prepared product. The baking quality of products was better in terms of cookie top grain score and overall acceptability for self rising flour prepared in our study than existing one. From economic point of view, we had selected sodium bicarbonate (1.10%) and ACP (1.4%) as the techno-economically most feasible leavening agent for formulation of cookies.

Table-5
Effect of self rising flour containing different level of ammonium bicarbonate on quality of cookies

Leavening Agent	**$(NH_4)HCO_3$*+1.5% ACP#**			**$(NH_4)HCO_3$+ 1.4% ACP**		
Level/ Quality Aspect	**W/T**	**Top Grain**	**Overall Acceptability**	**W/T**	**Top Grain**	**Overall Acceptability**
1.00	1.15	2.30	6.14	1.17	2.70	6.78
1.05	1.16	2.40	6.36	1.18	2.75	6.84
1.10	1.23	3.00	7.04	1.23	3.30	7.19
1.15	1.21	2.70	6.89	1.22	3.15	7.11
1.20	1.19	2.45	6.71	1.20	3.10	7.03
1.25	1.18	2.45	6.54	1.99	3.00	6.91
LSD ($p \leq 0.05$)	0.045	0.25	0.076	NS	0.26	0.055

* Sodium bicarbonate, # Acid calcium phosphate

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