Effect of Moisture on the Quality of Wheat Flour Stored for a Certain Period of Time

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***Abstract*- The effect that moisture may have on the quality of dough made from wheat flour stored at different moisture conditions was investigated. Our objective was to study the characteristics of wheat flour, its properties and their variations at different moisture contents at subsequent time intervals of 7, 14 and 21 days. Hardness is increasing with decrease in moisture content and highest value has been obtained at 98% concentration of sulphuric acid stored for a period of 30 days. The cohesiveness decreased with decrease with moisture content and the maximum value was observed at 30% sulphuric acid stored for a period of 14 days. Experiment was performed even at theoretical relative humidity of less than 1% .This also gave some significant variations in the result.**

Index Terms- Wheat flour, storage, sulphuric acid, time intervals, moisture, relative humidity.

1. INTRODUCTION

Storage of wheat flour at higher relative humidity unfavourably affects the quality of finally baked products. Studies have shown that baking performance of flour can be improved to the optimum ageing of the flour and that quality can be maintained for a specific period of time, which could be deteriorated totally with prolonged storage (Fisher et al., 1937). Storage environment is very critical factor in flour aging as temperature, time, moisture, relative humidity (RH), packaging material and microbial activity all affects the maturing of the flour (Wang and Flores, 1999). Flour aging is thought to occur naturally during storage of flour (Miranda Garcia, 2013), was thought to relate to oxidation of flour components including fatty acids and proteins (Cenkowski et al., 2000). Hrušková and Machová (2002) reported that storage time and conditions have an influence on the technological qualities of wheat flour and optimal maturation time depends on both the flour characteristics and storage conditions.

Cereal technologists commonly use empirical rheological and baking methods to predict end-product quality and these methods are often imitative of industrial processes and are rarely fundamental in nature (Miranda-Garcia, 2013). Studies reported that the baking qualities of wheat flour were substantially altered by the period and conditions of storage (Mis, 2003). During storage water absorption of flour increases, which results in improving the rheological characteristics of dough and increase its ability to retain gas and produce bread with higher volume (Wang and Flores, 1999). During the storage of the flour content of the sulphydryl groups (-SH) decreased gradually which results in the construction of disulfide bonds (-S-S-) involving the polypeptide chains of gluten proteins which leads to enhance the degree of polymerization of the proteins(Yoneyama et al., 1970; Chen and Schofield 1996; Wrigley and Bekes, 1999). According to Mis (2003) knowledge of the influence of storage period on the rheological properties of gluten should be known to the professionals as it will directly affect the quality of dough and bread.

Food texture is a collective term of sensory experiences originated from visual, audio and tactile stimuli. The sensation of food texture plays a crucial role in influencing consumers' liking and preference of a food product. Consumer concern and interest of food texture vary from one type of food to another. For solid foods, sensory experience associated with fracture and breaking could be the most relevant textural features, whereas the sensation of flow behaviour could be the most critical texture-related feature for fluid foods. For semisolid soft solid foods, different patterns of stress–strain deformation provide key information for the delicate texture variation among this type of food.(Chen, A. Rosenthal, in Modifying Food Texture, 2015).

2. MATERIALS AND METHODS

Commercial wheat flour was purchased from the local market in Jadavpur, Kolkata. Laboratory grade Sulphuric acid used was of (98% concentration). Care was taken so that the acid does not come in direct contact with the stored wheat flour.

The wheat flour was stored under pre-set conditions. The temperature of the operating room was regulated to 24 degree Celsius. The experiment was performed in a room with no contact to the outside surroundings. The flour was weighed (300g) and filled in each desiccators (3 of them).The target condition was to bring down the RH of storage condition to a desired value. For this sulphuric acid solution was used. Three solutions of sulphuric were prepared of 30%, 40% and 50% concentrations respectively.

The base of the desiccators was filled with sulphuric acid solution of a particular concentration as mentioned above. Then the measured quantity of the flour was placed in small glass beakers right above the base filled up with sulphuric acid. The three setups were now kept aside for a period of 7 days.

At the end of the 7day period, small quantity of wheat flour was taken from each of the desiccators and mixed with water in suitable proportion to prepare a dough in accordance with the standard procedures of AOAC 1990.The texture of the prepared wheat flour dough was measured in a TA XT plus Texture Analyser (Stable Micro Systems, UK).The double cycle curves were recorded for analysis.

Similar process was performed for the 14 day and the 21 day samples. The texture was analysed in the same TA XT plus Texture Analyser (Stable Micro Systems, UK).The double cycle curves were again recorded for analysis. The process was replicated for 3 times.

Based on the results obtained further tests were performed at higher concentrations of sulphuric acid to achieve theoretically achievable extremely low humidity conditions (with RH less than 1 percent).The concentrations of sulphuric acid used were 80%,90% and 98% respectively.

As mentioned above the base of each of the desiccators were filled again with sulphuric acid solution of 80%, 90% and 98% respectively. Then the measured quantity of wheat flour (300g) was placed in glass beakers and kept right above the base filled with sulphuric acid. The three setups were now kept aside for a period of 30 days.

At the end of the 30 day period, 50 g of the wheat flour was taken from each of the desiccators and mixed with water in suitable proportion to prepare a dough in accordance with the standard procedures of AOAC 1990.The texture of the prepared wheat flour dough was now measured in a TA XT plus Texture Analyser (Stable Micro Systems, UK).The double cycle curves were recorded for analysis. The process was repeated for the 60 day sample. The time period of storage was extended to 30 and 60 days respectively, to observe the textural changes in wheat flour if any at extremely low RH or theoretical RH values(of less than 1%).

3. RESULTS AND DISCUSSIONS

Table-1: Data obtained by Textural Analysis of dough prepared from Wheat Flour sample stored for a period of 7 days, 14 days and 21 days respectively in desiccators under desired RH of 75.9%, 57% and 36.9%.

DATA NUMBER	PROPERTIES	TIME(DAYS)	CONCENTRATION OF H2S04(RELATIVE HUMIDITY)		
			30%(75.9 % RH)	40%(57% RH)	50%(36.9 %RH)
1.	HARDNESS (gf)	7	0.378	0.514	0.351
		14	0.501	3.762	0.281
		21	0.608	0.327	0.234
2.	SPRINGINESS	7	0.988	0.852	0.825
		14	3.207	0.768	0.793
		21	3.817	0.691	0.681
3.	COHESIVENESS	7	0.611	0.362	0.397
		14	0.679	0.495	0.427
		21	0.349	0.316	0.352
4.	GUMMINESS	7	0.285	0.186	0.139
		14	0.883	0.136	0.103
		21	0.212	0.103	0.082
5.	CHEWINESSS	7	0.245	0.158	0.115
		14	0.537	0.075	0.093
		21	0.810	0.071	0.056
6.	RESILENCE	7	0.056	0.060	0.048
		14	0.059	0.064	0.059
		21	0.066	0.067	0.068

Table: Data obtained by Textural Analysis of dough prepared from Wheat Flour sample stored for a period of 30 days and 60 days respectively in desiccators under desired RH conditions maintained by sulphuric acid of concentrations 80%, 90% and 98% respectively. Data obtained is for dough of 5g of the wheat flour sample.

DATA NUMBER	PROPERTIES	TIME(DAYS)	CONCENTRATION OF H2S04(RELATIVE HUMIDITY)		
			80%	90%	98%
1.	HARDNESS (gf)	30 days	158.408	208.989	253.373
		60 days	57.69	82.484	76.912
2.	SPRINGINESS	30 days	0.758	0.407	0.388
		60 days	0.854	0.436	0.484
3.	COHESIVENESS	30 days	0.324	0.433	0.349
		60 days	0.307	0.282	0.253
4.	GUMMINESS	30 days	52.041	90.527	88.33
		60 days	17.701	23.284	19.442
5.	CHEWINESSS	30 days	39.449	36.88	34.243
		60 days	15.122	21.789	9.409
6.	RESILENCE	30 days	0.069	0.079	0.072
		60 days	0.048	0.07	0.07

TABLE 2

Hardness is increasing with decrease in moisture content and highest value has been obtained at 1% relative humidity stored for a period of 30 days as shown in the table-1. However there is an irregular trend observed at moisture content of 40% as noted from (Table 1). After 40% RH water absorption decreases. The springiness was found in wheat flour kept in desiccators with 30% sulphuric acid for 21 days as noted from (Table 1). The cohesiveness decreased with decrease with moisture content and the maximum value was observed at 75.9% relative humidity stored for a period of 14 days. (Table 1).The gumminess was found to decrease with the decrease of moisture content and the maximum value was observed at 1% RH stored for a period of 30 days (Table 2). The data of chewiness was observed in a similar manner for the wheat flour stored. In general the Chewiness decreased with decrease in moisture content and highest value was observed for about 1% RH stored for a period of 30 days (Table 2). The resilience almost varied linearly with storage period with a peak value obtained at 1% RH in a storage condition for 30 days as observed from Table 2. The analysis shows some general trends or patterns observed and further study needs to be done in order to make specific conclusions

4. CONCLUSION

The entire experiment was performed in order to understand the ideal storage conditions of wheat flour and to analyse whether a similar setup can be installed in an industrial scale. Sulphuric acid was used just as an RH controlling agent and can be easily replaced by another other substance with similar effects. Silica gel can be one such substitute. If the data is carefully analysed from the tables above then some distinguishable trends can be noticed. The above experiment has been performed for wheat flour, can be easily extended for other types of dough to observe the changes in the quality of the finally prepared product. The above data can serve as a quick guideline as to how to store wheat flour in the industrially or even domestically and in what manner would it influence the finally baked products. Dehumidifier and modified atmospheric packaging can be used on industrial scale. Toxicity analysis can also be carried out along with this study to see aflatoxin and mycotoxin content. Certain parameters become a key criteria in a particular product like hardness for biscuit or springiness for bread. It may be quite early to make any distinguishable conclusions and further study is being performed related to this aspect of study.

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