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INFLUENCE OF TEMPERING WITH OZONATED WATER ON RHEOLOGICAL PROPERTIES AND BAKING QUALITY OF SUDANESE WHEAT FLOUR

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Abstract

This Study was carried out on the effect of ozonated tempering on rheological properties and baking quality of two Sudanese wheat cultivars as well as to investigate its impact on the mold and yeast contamination. Two local cultivars: Debaira and Elneelain were treated with two doses of ozone (1.0 and 5.0 ppm). Rheological properties and total mold and yeast count were carried out for the two wheat cultivars. Baking quality and sensory evaluation were carried out for bread (loaf) made from the two cultivars ozonated and non-ozonated. Results indicated significant difference in the flour and bread quality of the two varieties. Both cultivars Debaira and Elneelainwere low in water absorption (62.7 and 58.8%), specific loaf volume (3.83 and 3.13 cm^3/g) and extensibility (147 and150 min), respectively. Treatment of ozonated tempering of the two wheat cultivars decreased alpha amylase activity, specific loaf volume and resistance in Debaira cultivar, while it increased these in Elneelain cultivar; however, the water absorption and degree of softening values for both cultivars decreased. The results from microbiological investigation showed that ozone treatment at 5 ppm were effective against mold, yeast an A. flavus de-contamination. Generally, Debaira cultivar had better bread making qualities attributes than Elneelain cultivar.

Keywords: *flour quality, baking quality, rheological properties, ozonated water,wheat*

1. INTRODUCTION

Wheat belongs to the grass family (Gramineae) genus (Triticum). Wheat is an important

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human food, its production being second to maize among the cereal crops. Wheat grain is a stable food used to make flour for leavened, flat and steamed breads, cookies, cakes, pasta, noodles and couscous and for fermentation to make beer, or biofuel (George, 1973).

Wheat was cultivated in the Sudan since B.C but until 1940’s production was confined to the northern region (16-22^{o}N), where inhabitants are traditionally wheat consumers. During the Second World War and because of the difficulties of importing wheat it was produced locally. Hence 20000 feddans of irrigated clays of central state (Gezira scheme) were cultivated and the trial was a considerably successful. The varieties grown were Giza 155 and Mexicani (Badi, *et al.*, 1978). However, in spite of success no wheat was produced in Gezira scheme after the war was over. This was because it became possible to import wheat and because the Gezira scheme tenants who had al-ready developed a taste for sorghum found it difficult with their dura production, a commodity which they considered safeguard for their maintenance and subsistence. In addition to the above reason, land and irrigation water formerly allocated to wheat production were needed for other crops within the rotation. After 1960’s wheat growing area had been extended southward to warmer regions to include new halfa and White Nile (12-15^o N) in addition to the irrigated scheme in Gezira.

Wheat in Sudan is grown under irrigation during the dry and comparatively cool winter season which extends from November to February. With the present commercial varieties, potential yield is limited by day temperature above 35^o C at any stage of crop development. The season with acceptable heat limit is short, 90 – 110 days (Kenneth and Leonard, 1973). The production of wheat is increasing progressively in developing countries that is why it has become one of the chief food grains, and yet great efforts are made to raise its production level to meet the great demand for the crop. These efforts can’t be completed unless some efforts are made to reduce losses that occur between harvest and consumption.

During harvesting and processing, and even during distribution, wheat products may become rather highly contaminated with various micro-organisms particularly mold and insects. Some of these molds may present a health hazard for humans. For this reason, reduction of pathogenic and toxogenic molds is highly desirable and the application of ozone may be a method of choice, particularly considering destruction of various nutrients by the use of heat or chemical preservatives to decontaminate which have various problems. Therefore the objectives of the study were to:

1. Evaluate the effect of ozonated tempering on rheological properties of wheat grain.
2. Investigate the possible effect of ozonated tempering on the initial mold and yeast count.

2. MATERIAL AND METHODS

2.1 Materials: Two local wheat cultivars, Debaira and Elneelain were obtained from Agricultural Research Corporation (ARC), Sudan (Harvest season 2007/2008. The grains were cleaned by hand, and all kernel samples were stored under ambient temperature during the study, all chemicals and reagents used were of analytical grade.

2.1.1 Ozonated water: Ozonated water was obtained from an ozone generator (Promaqua, Prominen company, type OZVa, TUV) using atmospheric air. Two concentrations were used, 1 mg/liter and 5 mg/liter.

2.1.2 Tempering: Clean wheat samples were tempered with distilled and ozonated water, each sample was transferred to tight glass jars and left for 24 hours. The amounts of tempering water were calculated according to the initial moisture content of the wheat.

2.1.3 Laboratory milling: Tempered wheat samples were milled in a BrabenderQuadrumat junior mill (Brabender OHG, Germany) to white flour (72% extraction rate). All flours were mixed well and deep freeze stored in tight jars.

2.2 Methods

2.2.1 Farinograph: Brabenderfarinograph method was carried out on ozonated and non-ozonated wheat flour according to AACC (2000).

2.2.2 Extensograph: Extensograph method was used according to ICC (2001).

2.2.3 Preparation of loaf bread: The type of bread (loaf) was made from ozonated and non-ozonated wheat flour using the procedure described by (Badiet al., 1978).

2.2.4 Physical characteristics of loaf bread: The loaves were left to cool for 1hr at room temperature (38 ± 2 oC).

2.2.4.1 Bread weight: The weight of loaf bread was taken in g.

2.2.4.2 Bread volume: The loaf volume was determined by the seed displacement method according to Pyler (1973).

2.2.4.3 Bread specific volume: The specific volume of the loaf was calculated according to the AACC method (2000) by dividing volume (cm3) by weight (g).

2.2.5 Sensory evaluation: The bread samples processed form each of ozonated and non-ozonated flours, assessed organoleptically by hedonic test according to the procedure described by Ihekoronye and Ngoddy (1985). The hedonic test depends on the range of:(9-8) as excellent; (7-6) as very good; (5-4) as good; (3-2) as fair; and (1) as poor.

2.2.6 Microbiological examination: A microbial analysis was carried out by enumeration technique for total mold and yeast, according to the methods described by Harrigan (1990). Fungal load determination was carried out as described by Kiss (1984).

2.2.7 Statistical analyses: Analysis of variance (ANOVA), followed by the least significant difference test (LSD test) were applied to all data obtained. All ak8nalyses were performed in triplicate (n=3). The level of significance used was 95% (Gomez and Gomez, 1984).

3. Results and discussion

3.1 Effect of ozonated tempering on rheological properties: Results of rheological measurement obtained from farinograph and extensograph are summarized in Tables (1) and (2). These results show the effect of ozonated tempering on rheological properties of ozonated and non-ozonated Sudanese wheat cultivars of the season 2007/2008.

2.2.8 Farinograph results: Water-absorption values of ozonated and non-ozonated wheat cultivars ranged from 57.2 to 62.7%. According to these results it is clear that ozonation treatment did not exhibit any remarkable differences in water-absorption with ozonation dose compared to the results of untreated cultivars. Dough development time of ozonated and non-ozonated wheat cultivars was found to be in the range of 1.7 to 5.4 min.

Generally, the water absorption and dough development time for Debaira cultivar were higher than Elneelain cultivar, this may be dependent on the protein content and quality of both cultivars. These results were in general agreement with the findings of Anaka and Tipples (1979) who reported that the dough development time decrease in the low protein content. Stability ranged from 5.1 to 7.4 min, Hoseney (1994) reported that the formation of new disulphide bonds in the presence of an oxid-izing agent would increase the strength of the dough with high stability and low degree of softening. Similarly, any cleavage of the disulphide bond would result in the weakness of the dough giving low stability and high degree of softening (Ainsworth, 1994).

Since ozone has an oxidizing nature, one would expect the formation of new disulphide bonds due to oxidizing effect, however, results show that this was not correct, considering that half-life of ozone in water is less than 20 min. (Liangji, 1999). It can be assumed that the contact time was not suf-ficient for such an oxidizing effect (Ibanoglu, 2001). The degree of soft-ening values were found to be in the range of 56 to 79 F.U. Debaira with ozonation dose 1.0 ppm gave the highest degree, while Elneelain with ozonation dose 1.0 ppm gave the lowest value.

Table (1): Effect of ozonated tempering on farinograph readings of two Sudanese wheat (flour) cultivars.

Cultivar	Ozonation Doses (ppm)	Water absorption corrected to 14%	Dough stability (min)	Dough develop-ment time	Degree of softening (I.C.C), FU
	0.0	62.7	6.2	4.7	69
Debaira	1.0	62.2	5.1	3.8	79
	5.0	60.7	6.2	4.5	63
	0.0	58.5	7.0	4.5	65
Elneelain	1.0	61.0	7.4	3.7	56
	5.0	57.2	6.3	1.7	60

2.2.9 Extensograph results: Extensograph mainly measures the energy in (cm2), resistance in BU, extensibility in (mm) and resistances to extension. According to the results in Table (2) ozonated tempering of Debaira wheat flour exhibited steady increase in the energy, resistance and extensibility, also: there was decrease in extensibility at 45, 90 and 135 minutes, compared to the ozonated cultivar. While in Elneelainwheat flour there was clear decrease in extensibility. The results also showed that as fermentation time increased the energy and resistance values increased; the quotient for resistance to extensibility for ozonated and non-ozonated samples increased for both cultivars. Oxidizing agents are used to improve the bread making capacity of flour. The use of oxidants such as acetone peroxide and chlorine dioxide (Hoseney, 1994) would decrease the extensibility of the dough while maximum resistance and energy values would be increased giving the dough more strength at the expense of extensibility. Ozone is an oxidizing agent and the results in Table (3) show that tempering with ozo-nated water did not alter the extensograph results of the flours aggressively, suggesting no net oxidizing effect of ozone on the wheat kernels during tempering stage (Ibanoglu, 2001). It might be that these changes in water distribution were highly responsible for the rheological and functional behavior of ozonated wheat samples.

Table (2): Effect of ozonated tempering on extensograph readings of two Sudanese wheat (flour) cultivars.

Cultivar	Ozo-nation doses	Energy (cm^2)			Resistance (cm)			Extensibility (mm)			R/E		
		B	C	D	B	C	D	B	C	D	B	C	D
Debaira	0.0	57	63	69	226	252	276	147	144	144	1.5	1.8	1.9
	1.0	52	52	55	178	210	250	164	143	137	1.1	1.5	1.8
	5.0	57	66	67	223	261	288	147	149	155	1.5	1.7	2.2
Elneelain	0.0	71	75	76	230	238	246	150	137	130	1.7	2.5	2.6
	1.0	58	62	61	218	254	268	151	143	139	1.4	1.8	1.9
	5.0	74	67	66	301	340	346	141	128	124	2.1	2.9	3.2

B: after 45 min. C: after 90 min. D: after 135 min. R/E: Resistance/Extensibility

2.3 Baking test: Bread specific volume ranged from 2.93 to 3.83 cm3/g. Debaira wheat without ozonated treatment gave the highest value, whereasDebaira with ozonated dose 5.0 ppm gave the lowest value. Generally Elneelain gave higher values of specific volume compared to Debaira cultivar which in the case of ozonated dose 0.0 ppm gained the highest value. The results showed significant differences ($P \leq 0.05$) among the two cultivars in their bread specific volume. These results were in disagreement with Ibanoglu (2001) who concluded that the ozonated tempering did not cause any chemical or physical changes. These results are relatively similar to that obtained by Elfadal (2008).

According to this result it is clear that specific volume of the loaf bread was affected by treatment of ozonation doses and by whenat quality, most probably due to the protein and gluten contents, gluten index, and sedimentation value, as Elagib (2002) reported.

2.4 The effect of ozonated tempering on sensory evaluation of bread loaf: The scores of aroma, taste, crust color and general acceptability of ozonated and non-ozonated bread samples are shown in Table (3). The aroma of bread scores ranged from 5.7 to 6.6 an insignificant difference in aroma among all samples was noticed.Debaira and Elneelain without treatment gained the highest values, while the Debaira with ozone dose 1.0 and 5.0 ppm gave the least values.

The taste scores of bread are found to be in the range of 5.5 to 6.3, statistical analysis of the results showed nonsignificant differences ($P \leq 0.05$) among the two cultivars in their taste scores.

Elneelain cultivar without treatment gave the highest score, also Elneelain with ozonated treatment dose 5.0 ppm gave the least score.

The crust color scores of bread are found to be in the range of 5.5 to 7.2.Analysis of variance showed nonsignificant differences ($P \leq 0.05$) among the two cultivars in their crust color scores.Debaira without treatment gained the highest value, whereas Debaira with ozonated treatment of 5.0 ppm and Elneelain without treatment gave the least value.

The general acceptability scores of bread were found to be in the range of 5.7 to 6.6. The general acceptability score of the bread made from Debaira without treatment gave the highest value, also Debaira and Elneelain with 5.0 ppm dose gave the least value, with no significant difference ($P \leq 0.05$).

Table (3): Effect of ozonated tempering on sensory evaluation of two Sudanese wheat (flour) cultivars.

Cultivar	**Dose ppm**	**Aroma**	**Taste**	**crust color**	**General acceptability**
	0.0	6.6^a	6.2^a	7.2^a	6.6^a
Debaira	1.0	5.7^a	5.7^a	6.1^a	5.9^a
	5.0	5.7^a	5.7^a	5.5^a	5.7^a
	0.0	6.6^a	6.3^a	5.5^a	6.4^a
Elneelain	1.0	5.8^a	5.9^a	5.7^a	5.9^a
	5.0	6.1^a	5.5^a	5.8^a	5.7^a

Means in the same column with different letters are significantly different ($P \leq 0.05$) according to least significant test.

Each value in the Table is a mean of 15 replicates.

3.4 Effect of ozonated tempering on total mold and yeast count: Mycological analysis showed that tempering the wheat kernel with interval. The number of colony counts (cfu) decreased as the ozone concentration in tempering water was increased (from 1.0 to 5.0 ppm). The microbial population of wheat kernel before milling is important for final microbial quality of the resulting flours. High numbers of microorganisms reduce the storage-life of the flours and cause a reduction in the overall quality (Ibanoglu, 2001).

The mycological infestation of wheat can be considered acceptable when fungi (cfu) are within the range $10^3 - 10^5$ per gram (Schnuerer and Jonson, 1992) and successfully used for wheat temperingfor the reduction of fungal populations, considering that ozone has approximately 30000 times more chlorine or disinfectants used in processing water.

4. Conclusions and Recommendations

The following conclusions can be derived from this work:

- The overall average dose of ozonated tempering was very effective in mold decontamination.
- Ozonated tempering has no direct effect on the nutritional value of wheat flour.
- After ozonated treatment cultivar Elneelain gave better flour quality for bread-making thanDebaira cultivar.

- The process of ozonated tempering is strongly recommended as disinfection process in wheat flour and it is even without affecting other qualities.

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