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Effect of addition of the emulsifier DATEM on sensory and staling characteristics of gluten- free Barbari bread

Zohreh Pourzafar¹, Sara Movahhed^{1*} and Hossein Ahmadi Chenarbon²

¹Department of Food Science, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran

²Department of Agronomy, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran

ABSTRACT

Celiac is a common disease caused by consumption of gluten and the only way of treating is to use a gluten- free diet throughout life. The aim of this study was to investigate the effect of DATEM at four concentration of 0.25, 0.5, 0.75 and 1% on sensory and staling characteristics of gluten- free bread prepared from a mixture of corn- flour and chestnut flour in an equal ratio. Different treatments were produced according to industrial method and staling assays were carried out using instron. Sensory assays were performed according to standard methods. In this research a completely randomized design was used in three replications followed by Duncan's multiple- range test. Use of DATEM increased shelf life of the product so that C₄ treatment (containing 1% DATEM) decreased hardness of breads with time significantly especially after 3 day of storage. Sensory analysis showed that samples containing 1 and 0.75% of DATEM had better texture, chewiness and porosity.

Keywords: celiac,, gluten-free bread, staling, the emulsifier DATEM

INTRODUCTION

Today many people suffer from celiac disease. This disease is caused as a result of consumption of some grains due to gluten protein. Consumption of gluten by celiac patients leads to inflammation of small intestine which in turn disrupts intake of essential minerals such as Fe, Ca and fat-soluble vitamins, and in some cases results in anemia and weight loss [11]. The only way of treating celiac is to use a gluten- free diet including rice, sorghum, corn and chestnut flour [6]. Gluten is the major protein present at wheat flour which improves bread quality due to increasing viscoelastic properties of dough and gas holding capacity. Absence of gluten from bread formulation leads to a weaker crumb and a more staled bread. Also it decreases dough resistance to mechanical operation thus disrupting fermentation process [1]. At present chestnut flour is the best replacer for wheat flour for preparing bread which can improve quality of the product. Since gluten free products lack Fe, vitamin and fiber, use of chestnut flour can be useful due to high nutritional value [6]. Chestnut flour contains a high amount of starch, vitamin, fiber, amino acids and minerals and certain sugars such as saccharose, glucose, fructose and raffinose. Also it is useful source of bioactive substances including lesitin, proteinase cysteine and quercetin. Furthermore consumption of chestnut is of high importance due to containing antioxidants [5]. Regarding limited shelf- life of chestnut, today derivatives of this fruit are produced in the form of chestnut starch or flour. Short shelf-life of chestnut is due to presence of high amounts of saccharose of high water activity. Therefore it has been attempted to increase its storage life using

techniques such as cooling and freeze-drying [3]. Corn flour can also replace wheat flour. It contains high amounts of vitamins and mineral including K, P, Zn, Ca, Fe, thiamin, niacin and vitamin B. Corn has more fat than wheat, rye and barely. Corn is poor terms of some vitamins such as niacin as well as amino acids such as lysine and tryptophan but it is a rich source of biotin and carotenoides [4]. On the other hand emulsifiers are used for enhancement of water retention capacity, improvement of volume and viscoelastic properties of bread. Emulsifiers are surfactants adsorbed into drops thus reducing interfacial tension [8, 7]. DATEM is an ester of diacetyl tartaric acid mono and triglyceride. It is a kind of oil in water anionic emulsifier which can improve elasticity and resistance of dough to extension as well as bread volume [8, 9]. Furthermore DATEM reduces the size of gas bubbles formed in dough and leads to formation of a micro-structure in bread, and its performance as a softener of crumb is related to reaction with starch especially amylose and amylopectin molecules which plays a role in staling retardation. Demirkesen (2010) investigated addition of chestnut flour to formulation of gluten-free bread and found that a mixture of chestnut flour and rice flour (30.70 ratio) combined with guar and xanthan (both at 0.25%) and 0.5% DATEM gave the best results. This research was attempted to present an appropriate formulation for preparing gluten-free Barbari bread the basis of chestnut flour and corn flour. The effect of the emulsifier DATEM at four different concentrations (0.25, 0.5, 0.75 and 1%) on sensory and staling properties of gluten free bread was also investigated.

MATERIALS AND METHODS

Chestnut flour (PRIMEAL Co., France), corn flour (Iran corn flour factory). DATEM (Palsgar, Denmark), the bakery yeast (Iran Molass Co.), salt (Hedieh Co.), sugar (Yes Co.) and shortening (Mahgol Co.) were prepared.

Analysis of flour sample

Chemical assays were carried out on the flour samples with three replications followed by staling assays. Sensory analysis was performed by panelists. The assays measured moisture (AACC, No. 16-44), ash (AACC, No. 0-1-08), protein (AACC, No. 12-46), fiber (AACC, No. 3105) and pH (AACC, No. 37) [2].

Evaluation of staling rate with Instron

Crumb hardness was evaluated using 1140 Instron according to AACC, No. 74-09 [2]. In order to assess staling rate, portions at dimensions of 2×2cm were cut from crumb. This assay was carried out at three time intervals (24, 48 and 72 hours after bake).

Statistical analysis

Data analysis was performed in a completely randomized design at three replications. and comparison of means by Duncan's multiple range test by SPSS software was performed.

RESULTS AND DISCUSSION

The results of chemical tests chestnut flour and corn flour are presented in table 1. Also the results of Tables 2 and 3, respectively to perform sensory tests and evaluation staling of gluten-free samples is discussed.

Table1. Results of the chemical characteristics test of chestnut flour and corn flour used in the production of Iranian Barbari bread gluten-free

Materials	Moisture (%)	Ash (%)	Protein (%)	Fiber (%)	pH
Chestnut flour	6.91	2.71	7.08	6.57	5.9
Corn flour	12.25	0.55	6.68	1.54	5.3

Table2. Test results of the sensory properties of gluten-free Iranian Barbari breads

Treatment	Figure & Shape	Surface	Crust	Porosity	Chewing	Hardness& Softness	Taste & Smell
C ₁	7.33 ^{ab}	3.33 ^a	7 ^a	8.66 ^b	10 ^b	12.33 ^c	10.83 ^{bc}
C ₂	7.66 ^a	3.66 ^a	7.16 ^a	9 ^b	10.5 ^b	14.33 ^b	11.66 ^{bc}
C ₃	8 ^a	3.66 ^a	7 ^a	9 ^b	10.5 ^b	14.66 ^b	13.33 ^{ab}
C ₄	8.66 ^a	4 ^a	8 ^a	12 ^a	11.75 ^a	18.66 ^a	15 ^a
C	6.33 ^b	3.33 ^a	6.66 ^a	8.33 ^b	9.5 ^b	12 ^c	10 ^c

In each column, means with the same letter are not significantly different (P<0.05)

Table3. Results of the test staling of gluten-free Iranian Barbari breads (N)

Treatment	C ₄	C ₃	C ₂	C ₁	C
24	6.40±0.51 ^a	9.76±0.51 ^b	10.48±0.51 ^b	14.69±0.51 ^c	18.21±0.51 ^d
48	11.70±0.37 ^a	13.22±0.37 ^a	18.13±0.37 ^b	28.15±0.37 ^c	36.25±0.37 ^d
72	14.27±0.27 ^a	22.63±0.27 ^b	29.06±0.27 ^c	41.76±0.27 ^d	44.62±0.27 ^e

In each row, means with the same letter are not significantly different ($P < 0.05$)

Results of chemical tests showed in table 1 that corn flour and chestnut flour are suitable for the production of Barbari bread gluten-free. Sensory analysis was performed by panelist. Based on table 2 a significant difference in form and shape was observed between C and other treatments; i.e. DATEM emulsifier improved form and shape of bread samples compared to C sample. Similar results were obtained by Kohler (2001) and Kohajdova et al., (2009). In terms of under surface of bread samples no significant difference was observed between treatments. In other words DATEM had no significant effect of this property although at higher concentration a slight improvement was observed quantitatively. Addition of DATEM improved crust compared with C treatment however this difference was not significant [6]. With regard to porosity there was a significant difference between C₄ and other treatments. The reason for increase in porosity of samples containing DATEM was more uniformed distribution of gas cells and reduced size of these cells [7]. Chewiness was improved in C₄ treatment compared with other treatments due to absorption of water into the emulsifier consumed [6]. A significant difference was observed between C₄ and other treatments in texture and structure. This improvement in texture of samples containing DATEM was attributed to formation of a hydrogenic bond with amylose and amylopectin molecules capable of enhancing protein density through binding to hydrophobic surface of protein and consequently forming a firm gluten network. Regarding flavor and aroma the highest and the lowest scores were related to C₄ and control treatments, respectively. In general DATEM improved flavor and aroma of the obtained breads [6]. The reason was that gases produced during fermentation caused a desirable porosity in bread texture and left little volatiles which enhanced flavor and aroma of the product [10]. Hardness of crumb was evaluated during three days of storage by using Instron (table 3). After 24 hours of bake the lowest and highest staling rate were related to C₄ and C treatments, respectively. In other words incorporation of DATEM into formulation of gluten free bread decreased mechanical staling of bread samples. Anti-staling property of emulsifiers was due to their ability to form a helixoids amylose insoluble complex and consequently prevent from its leakage into interring granular surface and limit its reaction with starch amylopectin. Such complexes led to retro gradation retardation [10]. Also after 24 hours of bake C₄ and C treatments showed the lowest and the highest staling rate respectively. After 72 hours of bake the same result was obtained. It was attributed to presence of DATEM in formulation of these bread samples which led to enhancement of elasticity compared with control sample. Furthermore function of DATEM as a crumb softener has been related to its reaction with starch especially amylose and amylopectin [8, 7].

CONCLUSION

Addition of the emulsifier DATEM to gluten- free formulation had different effects on sensory and staling characteristics of the obtained breads. Sensory characteristics were improved with DATEM concentration. C₄ treatments (containing 1% DATEM) showed the lowest staling at all three time intervals.

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