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Short communications

SUGAR BEET MOLASSES: AN INGREDIENT TO ENHANCE MICRONUTRIENTS AND FUNCTIONALITY IN BREAD

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ABSTRACT: Osmotic dehydration in sugar beet molasses as hypertonic medium was used to treat apples, plums, carrots and red cabbage. The study was aimed at determining the quality parameters of bread supplemented with the following ingredients:

- freshly treated fruits/vegetables i.e. non–powdered form (at 10% and 30% level, flour basis),
- dried and grinded powders derived from them (at 5% and 10% level flour basis),
- sugar beet molasses (at 5% and 10% level flour basis).

The results showed that these ingredients significantly improved the mineral content of breads. The most marked was the increase in K content: for lower supplementation level, 89.1% (bread with molasses) –94.1% (bread with plum, powder). For higher supplementation level, the rise in K content was 157.5% (bread with cabbage, powder) and 167, 5% (bread with molasses). Contents of Mg and Ca were also significantly increased as compared to the control. The highest increase in Mg and Ca was obtained by supplementation with cabbage at higher applied dose (around 58% and 100%, respectively). Moreover, the supplemented breads showed significantly higher antioxidant potentials with the highest increase measured in the breads made with plum (62.5–82% for 5 and 10% levels, respectively). The molasses–based ingredients influenced the physical, textural and sensory properties of bread by lowering the specific volume, increasing the crumb firmness and changing the color and flavor. However, the lower supplementation levels had relatively mild effect on these properties. The breads made with apples and plums were scored highest for flavor.

Key words: *bread, molasses, minerals, antioxidant activity, texture, quality*

INTRODUCTION

Sugar molasses is concentrated liquid syrup which remains after repeated crystallizations during sugar refining process. It is a mixture of sugar, non–sugars and water from which it is impossible to crystallize sugar under any circumstances (Higginbotham and McCarthy, 1998; Olbrich, 1963). Molasses contains high amounts of solids (≈80%), of which around 50% is sugar. Depending on origin, two kinds of molasses can be distinguished: beet molasses and cane molasses. There are differences in the chemical composition of the two molasses: beet molasses has more saccharose, very little invert, more non–sugar substances and ash (Higginbotham and McCarthy, 1998; Olbrich, 1963). Unlike cane molasses, beet molasses contain rafinose and betaine.

Besides approximately 50% of saccharose, 1% rafinose and less than 1% invert sugar, beet molasses contains considerable amounts of important micronutrients such as minerals, proteins, vitamins, choline, glutamine acid, organic acids, pectin, etc. (Šušić and Sinobad, 1989). It is an appreciable source of potassium, calcium and iron. Sugar beet molasses also contains phenolic compounds (Maestro–Durán et al. 1996) although they have not been well documented. Phenolic substances have been mostly associated to the antioxidative action of material (Mišan, 2010). Aqueous extracts of cane and beet can be used for manufacturing antioxidants for functional food products (Chou, 2003). Taken together, these results suggest that cane and beet sugar molasses contain various compounds with beneficial effects for health. Some nutritionists highly appreciate sugar molasses and recommend its daily administration to protect health (Andrejević and Stevanović, 1967).

Sugar beet molasses is rarely used in human consumption due to its astringent off-flavor and aroma, in contrast to cane molasses. However, few researches showed that, at appropriate doses, sugar beet molasses can be successfully incorporated to various food (bread and bakery products (Pribiš et al., 2008; Šimurina et al., 2006; Lević et al., 2005a,b), meat products (Svrzić et al., 2006)) without drastic impairment of sensory properties. It has been also shown that sugar beet molasses can be used as osmotic agent due to high content of solids and liquid aggregate state (Filipčev et al., 2008; Lević et al., 2007; Filipčev et al., 2006). The use of molasses in processes of osmotic dehydration of fruits and vegetables potentially broadens the food applications of molasses. By its nature, fruits have great potential for use in bakery industry to improve the functionnal properties of products (Cvetković et al., 2009).

In this study, bread was enriched with sugar beet molasses or with fruit/vegetable ingredients obtained by osmotic dehydration in molasses with the objective to assess various quality aspects of bread. Two types of osmodehydrated ingredients were used: a) pieces of fruits/vegetables obtained after osmotic dehydration *as is*; b) dried and grinded powders of osmotically dehydrated fruits/vegetables.

MATERIAL AND METHODS

Ingredients used for breadmaking were standard and all from commercial source and included wheat flour type 500, refined granulated sugar, fresh compressed yeast, vegetable fat, salt, skimmed milk and bakery improver. Molasses (80% solids) was supplied from the sugar manufacture in Bač, Serbia. Apples (var. Idared), plums (var. Stanley), carrots and red cabbage uniform in size and quality were obtained from the local market.

Before osmotic dehydration, fruits and vegetables were washed and cleaned. Carrots were peeled while apples and plums were analyzed with their skin on. Apple and carrot samples were cut with a cork borer in a cylindrical shape of 20 mm diameter and 20 mm height. Samples of plums and cabbage were cut into cubes of approximately 1 cm. The fruit pieces were separately placed into molasses contained beakers and lightly weighted to keep them immersed. The ratio of fruit cubes and molasses was 1:4 by weight. The beakers were covered with a plate to reduce moisture loss and placed in thermostat at constant temrature 55 °C. The samples were taken out from the osmotic medium after 5 hours, rinsed and lightly blotted with tissue paper to remove excess molasess.

Breads were prepared according to standard procedure under laboratory conditions as described in (Filipčev et al., 2010). The effect of ingredients was studied at two doses: lower (5% flour basis for powdered forms and pure molasses i.e. 10% flour basis for non-powdered ingredients) and higher doses (10% flour basis for powdered forms and pure molasses i.e. 30% flour basis for non-powdered ingredients). Bread variants enriched with osmotically dehydrated fruits/vegetables were compared with a control sample (white bread) and bread with added molasses. Breads were analyzed for chemical composition, antioxidative potential, textural properties and sensory quality.

RESULTS AND DISCUSSION

Mineral composition of enriched breads

The addition of molasses and OD ingredients significantly affected the mineral content of enriched breads (Table 1).

Table 1.
Mineral content (g/100 g dry basis) of breads enriched with osmodehydrated fruits/vegetables

Minerals	Control	Molasses	Non–powdered form				Powdered form			
			Apple	Plum	Carrot	Cabbage	Apple	Plum	Carrot	Cabbage
K	207.50	392.30	255.05	278.17	314.50	323.63	284.00	402.80	354.30	376.50
		555.00	*338.01*	*391.75*	*496.75*	*524.50*	*355.10*	*492.50*	*496.20*	*534.37*
Na	619.20	612.90	610.41	620.76	634.40	640.61	605.50	603.20	623.40	632.50
		609.00	*584.18*	*589.40*	*632.10*	*652.05*	*593.80*	*592.80*	*631.50*	*649.70*
Mg	17.90	21.59	18.70	18.93	19.96	21.97	18.50	19.00	20.50	23.30
		25.10	*19.42*	*19.31*	*22.33*	*28.07*	*18.90*	*20.70*	*22.70*	*28.30*
Ca	33.86	41.66	36.03	38.43	45.55	46.58	37.25	40.11	49.20	51.61
		50.54	*39.39*	*44.20*	*64.86*	*68.00*	*40.46*	*46.10*	*63.70*	*68.31*

Values given in italics represent means obtained at higher levels of ingredient doses.

As compared to the control, the contents of potassium, magnesium and calcium were increased, of which the most prominent increase was observed regarding the potassium content. Sodium content did not significantly vary in comparison to the control but it tended to be lower in breads with fruit ingredients and higher in breads with vegetable ingredients.

In graham breads, K and Ca levels range from 250–300 mg/100 g and 25–30 mg/100 g, respectively (Biró and Lindner, 1988). Potassium and calcium levels observed here (255.0–555.0 mg/100 g d.b. for K and 36.03–50.54 mg/100 g d.b. for Ca) revealed that, by supplementing white bread with molasses and OD ingredients pretreated in molasses in powdered or non-powdered form, the content of these minerals reaches or exceeds the levels found in graham breads which undoubtedly confirm the value–adding potential of molasses–based ingredients in bakery products. Moreover, dietary intake of potassium has been recently indicated as a public health concern for the general public in the policy document released by the U.S. Department of Agriculture and U.S. Department of Health and Human Services (2010) because the intake of potassium by Americans is much lower than recommended which additionally support the nutritive potential of the tested ingredients.

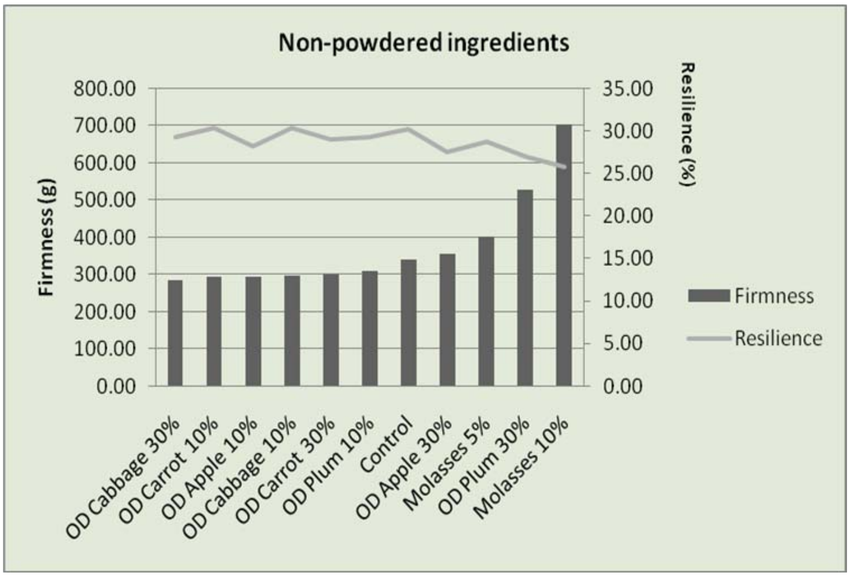
Antioxidative potential of enriched breads

In this study, the breads made with various molasses–based ingredients were tested for the antioxidant content using DPPH, a stable radical, as the detection agent. The addition of molasses and molasses–based ingredients significantly increased the antioxidative activities in the breads depending on the type of ingredients used and the supplementation level. In the case of non–powdered ingredients, antioxidant potential was raised by 10.4% (in bread with 10% OD carrot) and by 54.8% (in bread with 30% OD plum) in comparison with white bread control. The highest increase (82%) in the antioxidative potential was measured in the bread enriched with 10% powdered OD plum. High increase figures were determined for some other bread variants; such as variant with 5% powdered OD plum and 10% powdered OD cabbage and apple with increase figures of 60–67% in comparison with control. The addition of molasses also significantly increased antioxidantive potential which was increased by 24.2% and 42.6% for lower and higher applied dose, respecttively.

Such effect is presumably due to natural presence of compounds with high antioxidative potency in ingredients. Plums, red cabbage and apples are rich sources of such bioactive compounds. Molasses also contain substances with high antioxidative potential which partly originate from sugar beet and partly are generated in the sugar manufacturing process (melanoidines, sugar anhydrides, etc.).

Sensory and textural properties of enriched breads

In bread variants with non–powdered ingredients, specific volume of bread decreased only at higher doses whereas powdered ingredients at all applied doses significantly reduced specific volume in comparison to white control bread.The addition of ingredients in powdered form significantly increased bread crumb firmness in comparison to the control (Figure 1). This increase was most prominent at higher level of supplementation. In the case of non–powdered ingredients, firmness increase was less prominent; the majority of bread variants had similar firmness to that of the control whereas bread with 30% cabbage was significantly softer presumably due to high fiber content in cabbage. The highest firmness increase was measured for the bread with 10% molasses, 10% powdered OD apple and 30% non–powdered OD plum.



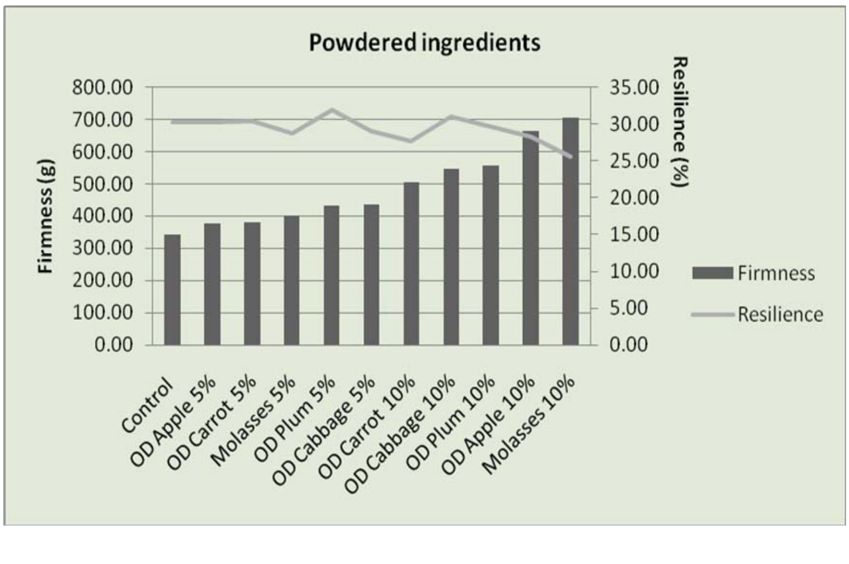


Figure 1. Textural properties of breads enriched with powdered and non-powdered molasses–based ingredients

Breads with higher firmness had signify-cantly lower crumb elasticity but in the case of bread with non-powdered ingre-dients the elastic-city of all variants did not significantly vary from the control.

Sensory evaluation showed differences between the samples. Powdered ingre-dients increased markedly crust and crumb color of the breads. Aroma profile was markedly altered in comparison to the typical fermented wheat dough aroma of the control bread especially in the samples made with the powdered ingredients; aro-ma on fruit/vegetable and caramel pre-vailed. Higher doses of powdered ingre-dients caused the presence of slightly burnt aftertaste which was especially cha-racteristic for the samples made with OD plum powder. Similar aroma profile was registered in the samples made with OD fruit pieces but characterized with lower intensity and absence of burnt sensation. None of the bread variants were dis-qualified which means that taste and aro-ma of the breads were acceptable. Bread variants with fruit-based ingredients were scored higher for overall acceptability in comparison to those with vegetables.

CONCLUSIONS

This study demonstrated the value-adding potential of molasses and molasses based ingredients in preparation of bread. Their incorporation into standard wheat bread formulation produced considerable effect on physicochemical and sensory proper-ties. Sugar beet molasses based ingre-dients significantly contributed to increa-sed antioxidative potential and enhanced content of minerals (especially K and Ca) matching those of graham breads. Crumb and crust color of breads were darker and aroma was altered. Specific volume and textural properties of bread were impaired but to statistically significant extent only in the case of higher supplementation levels. Yet, the panelists did not found any of the bread variants unacceptable although bread variants with fruit-based ingredients were more preferred.

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МЕЛАСА ШЕЋЕРНЕ РЕПЕ: САСТОЈАК КОЈИ ПОБОЉШАВА САДРЖАЈ МИКРОНУТРИЈЕНАТА И ФУНКЦИОНАЛНОСТ ХЛЕБА

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Сажетак: У раду је испитиван ефекат додатка чисте меласе и воћа/поврћа (јабука, шљива, мрква и црвени купус), претходно осмотски дехидрираних у меласи шећерне репе, на квалитет хлеба. Испитиване су следеће групе суплемената у две дозе:

- чиста меласа (5 и 10%, рачунато на брашно),
- свежи (у облику комадића осмотски дехидрираног воћа/поврћа, 10 и 30%, рачунато на брашно),
- у праху (осушено и самлевено осмотски дехидрирано воће/поврће, 5 и 10%, рачунато на брашно).

Добијени резултати су показали да су испитивани додаци утицали на значајно побољшање минералног састава хлеба. Најзначајније повећање у односу на контролни је забележено у садржају калијума: за ниже дозе додатака, највеће повећање се кретало у опсегу 89.1% (хлеб са меласом) –94.1% (хлеб са шљивом у праху), док су за више дозе додатака забележена следећа максимална повећања: 157.5% (хлеб са купусом у праху) и 167.5% (хлеб са меласом). Хлебови са додацима су такође имали значајно више садржаје магнезијума и калцијума у односу на контролни хлеб. Највиши садржаји Mg и Ca су одређени у хлебовима са додатком више дозе купуса у праху (58 и 100%, респективно). Хлебови са додацима су показивали значајно виши антиоксидациони потенцијал, при чему су највиши потенцијали забележени у хлебу са додатком шљиве у праху, 62.5–820% за 5 и 10% додатка, респективно.

Додаци на бази меласе су утицали на промену физичких, текстурних и сензорских својстава хлеба у правцу смањења специфичне запремине, повећања чврстоће средине и потамњивања боје. Међутим, при нижим дозама додатака, ове промене су биле мање изражене. Хлебови са додатком јабуке и шљиве су оцењени као најбољи по укусу.

Кључне речи: *хлеб, меласа, минералне материје, антиоксидациона активност, текстурна својства, квалитет.*

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