Effect of Composite Milled Wheat Flour and Flour Improvers on The Quality of Pan Bread

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ABSTRACT

The goal of the present study was to produce two wheat flour composites, one from all wheat flour streams (straight flour) and the second from the best two wheat flour stream blends obtained from Australian and Russian wheat. The two flour composites were evaluated through the parameters of pan bread produced in the presence and absence of wheat flour improvers. The results indicated that adding the flour improvers by half of the normal improver doses to the flour stream blends resulted in an improvement in the physical properties of pan bread (loaf volume and specific volume). Also, the crumb texture (hardness) of the pan bread was more softer as compared with that made from the composite straight flour containing the high or normal dose of the flour improvers. The data revealed that the pan bread produced from the flour of selected stream blends containing only the half dose of improvers had superior score values of sensory characteristics. Furthermore, the bread was much soft after 6 days of storage. Moreover, the pan bread made from the flour of selected stream blends which contain a quarter dose of improvers still softer than that of composite straight flour contained the normal dose of improvers.

In conclusion, the blending process of the selected streams caused an improvement in the properties of the flour as compared with the straight composite flour. Also, the results revealed that the amount of added improvers can be reduced to half only by using the blending process for the flour streams.

Keywords: Pan bread, flour composites Australian wheat, Russian wheat, flour stream blends.

INTRODUCTION

Bread is the most basic food consumed in different regions of the world. Bread- making a skill, craft, technology and science has been around for many thousands of years and many of the key ingredients and process technologies have been established. (Bushk & Rasper, 1994). Faubion & Faridi (1995) classified the different breads of the world as follows: those with high specific volume, such as the pan breads of the UK, North America and other Western countries. Those with medium specific volumes, such as French bread. Those with low specific volume, e.g. flat breads of the Middle East and Eastern countries.

The ability to process wheat flour into a wide range of end products relies heavily on the rheological properties of the dough. In bread baking, the dough needs to have the properties that enable it to stretch in response to gas expansion (extensibility), but strength should be appropriate to allow bubble expansion, while preventing the collapse of cell walls (Wrigley *et al*., 2006, Ishida & Steel, 2014).

Bread quality is determined by the complex interactions of the raw materials, their qualities and quantities used in the recipe and the dough processing method. Numerous studies have shown that the quality of bread can be assessed by measuring loaf volume, and the bread crumb properties were taken into consideration only in a minority of these studies. On the other hand, several studies have focused on determining the relationship between the flour and dough and bread properties. The loaf volume potential was found to be related to the protein content of wheat flour. The higher the protein content of a flour is the better because its ability to trap carbon dioxide gas and produce the larger bread volume. Flour protein quality is therefore linked to the way the protein allows the gas cell walls to expand. Insufficiently elastic gluten leads to low bread loaf volume as gas diffusion is rapid. Increased elasticity leads to greater loaf volume up to a point, but overly elastic gluten impedes the expansion of gas cells, resulting in lower loaf volume. In practice, it appears to be impossible to make a good-quality loaf of bread from flour that contains a low level (e.g., 8%) of protein. A typical flour protein content for bulk fermentation would be 12% or greater. Therefore, both a certain concentration and a certain quality of wheat flour protein are needed to produce a good quality loaf. traits of a baked product (Edwards, 2007, Wang *et al*., 2007, Khan & Shewry, 2009, Różyło & Laskowski, 2011).

The highest loaf volume of pan bread was found to relate with higher values of wet gluten, gluten index and dough stability time. Consequently, wheat flour with a higher level of α-amylase activity gave a highly specific volume of pan bread (El-Porai *et al*., 2013).

The visual and physical texture of bread crumbs are important quality attributes that largely determine overall bread characteristics and quality to the baker and consumer. The visual and physical texture of leavened baked goods are influenced by many factors including flour strength and protein content. With increasing flour strength, there was a clear trend to increase in loaf volume, more uniform and more extensible bread crumb. (Zghal *et al*., 2001, Tronsmo *et al*., 2003, Różyło & Laskowski (2011). The relationship between flour quality and baked product quality, (bread, cookies, and cakes) have been widely and traditionally used. The darkening crust colour was observed for flour obtained from breaks with progressive milling (Kweon *et al*., 2011, Brütsch *et al.,* 2017).

Bread staling is a complex and not completely understood phenomenon. It refers to all the changes which occur in bread after baking other than spoilage by microorganisms. It includes changes in both crust and crumb. The crust, which in its fresh state is relatively dry, crisp and brittle, becomes soft and leathery on staling due to the migration of moisture from the crumb. This increase in crust moisture is companied by the changes in taste and aroma, increase in each hardness, opacity, crumbliness, crystallization of crumb, and increase in crumb firmness during storage (Kim & D'Appolonia, 1977, He & Hoseney, 1990, Hebeda, *et.al*.,1990, Leon, *et al*., 2006)

A lot of components are added in small quantities to improve dough characteristics during processing and the quality of the pan bread in terms of flavour, texture and shelf life. Baking enzymes are used as flour additives and they are the best alternative to chemical compounds because they are generally recognized as safe and do not remain active after baking (Popper *et al*., 2006, Dagdelen & Gocmen, 2007, Whitehurst &Van oort, 2010 , Silva *et al*., 2016).

Nowadays there is a trend of using small amount of additives to improve dough characteristics during processing and to obtain the necessary product qualities. This trend has placed a greater emphasis on the understanding of the interactions of ingredients and processing methods and improvements in this understanding will undoubtedly lead to further changes in the production of what is probably the original processed food (Ou.*et al.,* 2019)

The aim of the present study was to investigate the effect of milled composite flour of Australian and Russian wheat and the added improvers on pan bread quality. The physical properties of the produced pan bread including: the loaf parameters, crumb characteristics, sensory characteristics, and staling properties were investigated. Also, to study an attempt to reduce the usually added quantities of flour improvers.

MATERIALS AND METHODS

Materials

Two different types of wheat (*Triticum aestivum* L.) available in Egypt were used: Australian wheat (Prime hard wheat) and Russian wheat grade 3 according to the Gosudarstvennye Standarty [GOST] (Abo-Deif *et al*., 2019). The wheat samples were obtained from the Arabian Milling and Food Industries Company, Alexandria. The selected 12 flour mill streams were collected (from 44 flour mill streams) during the normal milling process of the two wheat types .The five blended variants (A, B, C, D and E) were obtained from blending the twelve flour streams belonging to both wheat types as described by (Abo-Deif *et al*., 2021).

Methods

Application of composite flour

Two composite flours were prepared from the flour mill streams produced from the two wheat types (Australian and Russian). The first one (control) was prepared by blending all flour streams (straight flour) obtained from each wheat type at a ratio of (1:1 w/w) to form composite of all streams. The second composite was prepared by blending the best two stream blends obtained from Australian and Russian flour streams according to their rheological properties and baking tests especially dough stability and specific loaf volume of pan bread (Abo-Deif *et al*., 2023). These blends are stream blends A and B for Russian and Australian wheat flour respectively. They were blended at a ratio of (1:1 w/w) to form composite of the selected flour streams.

Three treatments were carried out for the composite selected stream blends as follow:

1- Treatment (T_0) the control without added improvers.
2- Treatment (T1) with added half of the normal dose of improvers (447.5 ppm)
3- Treatment (T2) with added quarter of the normal dose of improvers (223.75 ppm)

The normal dose of improvers (895 ppm) used in the present study was equivalent to that used in Arabian Milling and Food Industries Company, Egypt. It consists in (ppm) for each: 190 Ascorbic acid, 10 Glucose oxidase, 30 Calcium peroxide, 20 α-amylase, 30 Hemicellulase, 200 Soya, 15 Lipase and 400 Sodium sterol lactate

Pan bread preparation

The two composite flours were used to prepare pan bread with and without adding improverss according to (Abo-Deif *et al*., 2019).

Physical properties of pan bread.

The bread loaf weight (g) was recorded after cooling the bread for 1 h, and the bread loaf volume (cm^3) was measured by the rape seed displacement (AACCI 2000, method 10- 05.01).The specific volume (cm^3/g) of bread was calculated by dividing the volume by the weight. The Crumb firmness or hardness was determined using Texture Analyzer Perten Instruments TVT type 6700 (Huddinge, Sweden). Texture profile analysis was carried out in a single compression cycle using 25 mm diameter stainless steel cylinder probe. Bread firmness and staling rate were recorded by measuring the percentage of moisture, alkaline water retention capacity (AWRC) and hardness or force deformation (AACCI 2000, method 10-05.01).

Sensory evaluation of pan bread:

The pan bread loaves were organoleptically evaluated for general appearance, crust colour, taste, odour, crumb colour and structure by 10 trained panellists of the Food Science & Technology Department, Faculty of Agriculture, Alexandria University, according to Gujral, *et al* (2004).

RESULTS AND DISCUSSION

Effect of flour improverss on pan bread quality:

Physical properties of pan bread:

Loaf volume:

The results in Figure (1) show the effect of adding flour improverss on the properties of pan bread made from the two types of composite flour, compared to the control (without improvers).

It is worth to mention that the obtained data show that adding flour improverss resulted in an increase in loaf volume of bread made from the two types of composite flours.

Concerning the type of composite flour, the loaf volumes were 855 and 1410 cm^3 for pan bread made without improverss for the control (C_0) of composite straight flour and composite flour of selected streams (T_0), respectively. The percentage of increasing rate in loaf volume was about 65% due to using the composite flour of the selected streams as compared to composite straight flour. This can be attributed to the blending process of the selected flour streams which resulted in an improvement in loaf volume than that produced from composite straight flour of all streams.

Also, this may be due to the superiority of all physicochemical properties (wet gluten, gluten index, and rheology) of each stream blend (stream blend B and A for Australian and Russian types, respectively) to those of straight flour for the two types of wheat under study (Abo-Deif *et al*., 2023).

In addition the normal dose of improvers (~895 ppm) to the composite straight flour (C^+) resulted in about a ~75 % increase in the loaf volume (1495 cm^3) as compared with that free from the improvers (C_0). In contrast, the loaf volumes of the composite flour of selected stream blends T_1 and T_2 were 1515 cm^3 and 1430 cm^3 owing to adding half and quarter of the normal improvers dose, respectively. Consequently, the increase rates of their volumes (T_1 and T_2) were only~ 7.44% and1.42 %., respectively as compared with that from composite flour free from improvers (T_0).

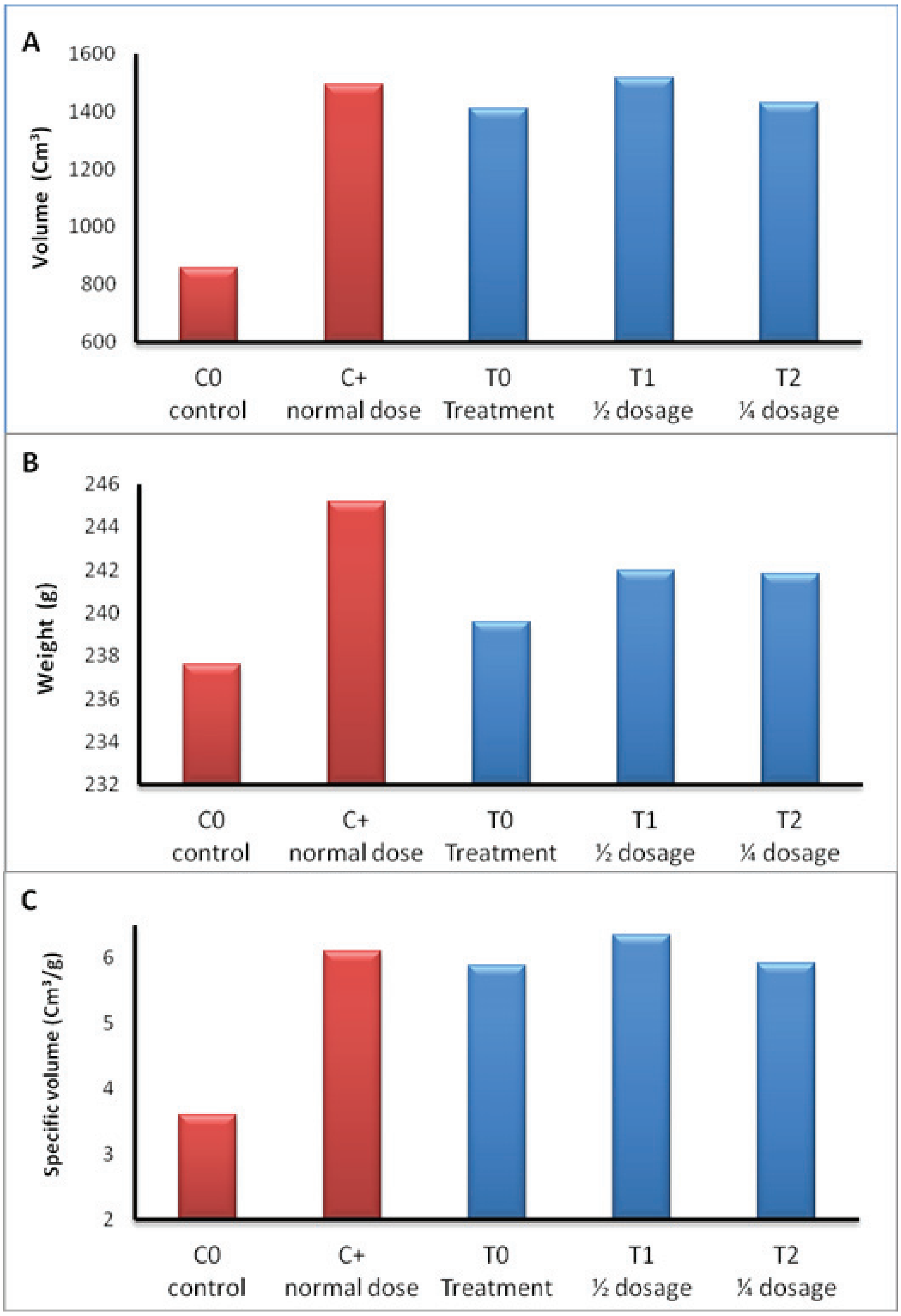

Fig. 1: Physical properties of pan bread made from composite flours with and without improvers

Loaf weight:

Concerning the loaf weight, there were slight differences in the loaf weight of pan bread made from the two types of composite flours free from improvers (C_0 and T_0) as shown in Figure (1) .On the other hand, the loaf weight (245.2g) of bread made from composite straight flour containing improvers (C^+) was higher than those made from a composite of selected stream blends containing improvers (T_1 and T_2). They were 242 and 241.8 g, respectively. Also, it can be noted that increasing the improvers dose with the composite flour of selected stream blends did not affect the loaf weight.

Specific volume:

The data given in Figure(1) show that the specific volume (5.88 cm³/g) of pan bread made from the composite flour of selected streams (T_0) without improvers was higher than that (3.60cm³/g) of composite flour of all streams (C_0).

Adding improvers, regardless to the dose, to the composite selected stream blends flour (T_1 and

T_2) increased the specific volumes (6.34 and 5.91 cm^3/g), respectively compared to either the composite flour of selected stream blends without improvers (T_0) or the composite straight flour (C_0).

Concerning the improvers dose, the highest value of specific volume (6.34 cm^3/g) was found when adding half of the dose (447.7 ppm) to composite selected stream blends (T_1) followed with that (6.1cm^3/g) for composite straight flour (C^+) containing the normal dose (895 ppm) while the lowest one (5.91 cm^3/g) was found for the composite of selected stream blends (T_2) containing the lowest dose of improvers (223.75 ppm). Generally, the rate of specific volume increased by (62%)owing to the change in the composite flour type from straight flour (C_0) to selected streams flour (T_0). On the other hand, the increase rate of specific volume was only 7.8% after adding half of the improvers dose (T_1). In contrast, there was a slight improvement in the specific volume due to adding a quarter of the improvers dose for the composite of selected stream blends (Figure1).

Generally, this result agrees well with that reported by El-Porai *et al*.,(2013) and (Abo-Deif *et al*.,2019) who stated that wheat flour with higher level of α-amylase activity (lower falling number) gave pan bread of highly specific volume.

From the previous results it was clear the pan bread made from the flour of selected stream blends contained only the half dose (T_1) of the improvers was superior than that made from composite straight flour containing the normal dose (C^+)

Crumb characteristics of fresh pan bread

Figure (2) shows the moisture content, hardness and ability of alkaline water retention for crumbs of fresh pan bread made from the two composite flour types (composite selected stream blends and composite of straight flour) with and without improvers. The moisture content of all tested pan bread varied from 42.59 to 43.81 %. Crumb moisture (43.18%) obtained from composite straight flour (C_0) was slightly higher than that (42.59%) of pan bread obtained from composite selected stream blends (T_0). Regardless to the dose of improvers a slight increase was observed in the crumb moisture of the bread made from all composite flours (C^+, T_1 and T_2) as a result of adding flour improvers.

It was obvious that there are variations in the crumb hardness of the bread made from the two types of composite flours either with or without improvers. The crumb hardness (334g) of the pan bread of the composite selected stream blends (T_0) was softer than that (497g) of the composite straight flour (C_0). In addition the flour improvers resulted in the softness of the crumb of bread made from both composites, C^+ and T_1 (containing 895 and 447.4 ppm of the improvers, respectively).The increase rate of softness was ~ 27 only for C^+. Meanwhile, it reached to ~47% for T_1. It was clear that adding the half dose of improvers to the composite flour of selected stream blends was more effective in improving the crumb texture than that high or normal dose added to the composite of straight flour. On the other hand, using a low dose of improvers (223.7 ppm) did not affect on the crumb texture.

Alkaline water retention capacity (AWRC)

The AWRC is used as a measure of bread freshness. The freshness characteristics of the crumb of pan bread in the term of AWRC show diversity in crumb freshness values as shown in Figure (2). The type of composite flour and the addition of improvers affected the degree of bread freshness. The value of the AWRC (287.3%) of pan bread made from the composite straight flour without improvers (C_0)was higher than that (242.2 %) of its counterpart made from the control composite flour of selected stream blends(T_0). It was observed that adding the highest level of flour improvers to the composite straight flour (C^+) reduced the alkaline water retention capacity value (264.8%). In other words, the dose of improvers added to the control (C_0) caused a reduction in its freshness (C^+). In contrast, adding both levels of improvers (half and quarter) to the composite of selected flour of stream blends resulted in an increase in their alkaline water retention capacity values. The rate of increase was about ~ 23 % and 19 %, respectively.

It was clear that adding only the half dose of the improvers to the composite flour of selected stream blends resulted in enhancing the freshness of the pan bread. In conclusion, the quantity of the added improvers to the stream blends can be reduced to half only as compared to the straight flour.

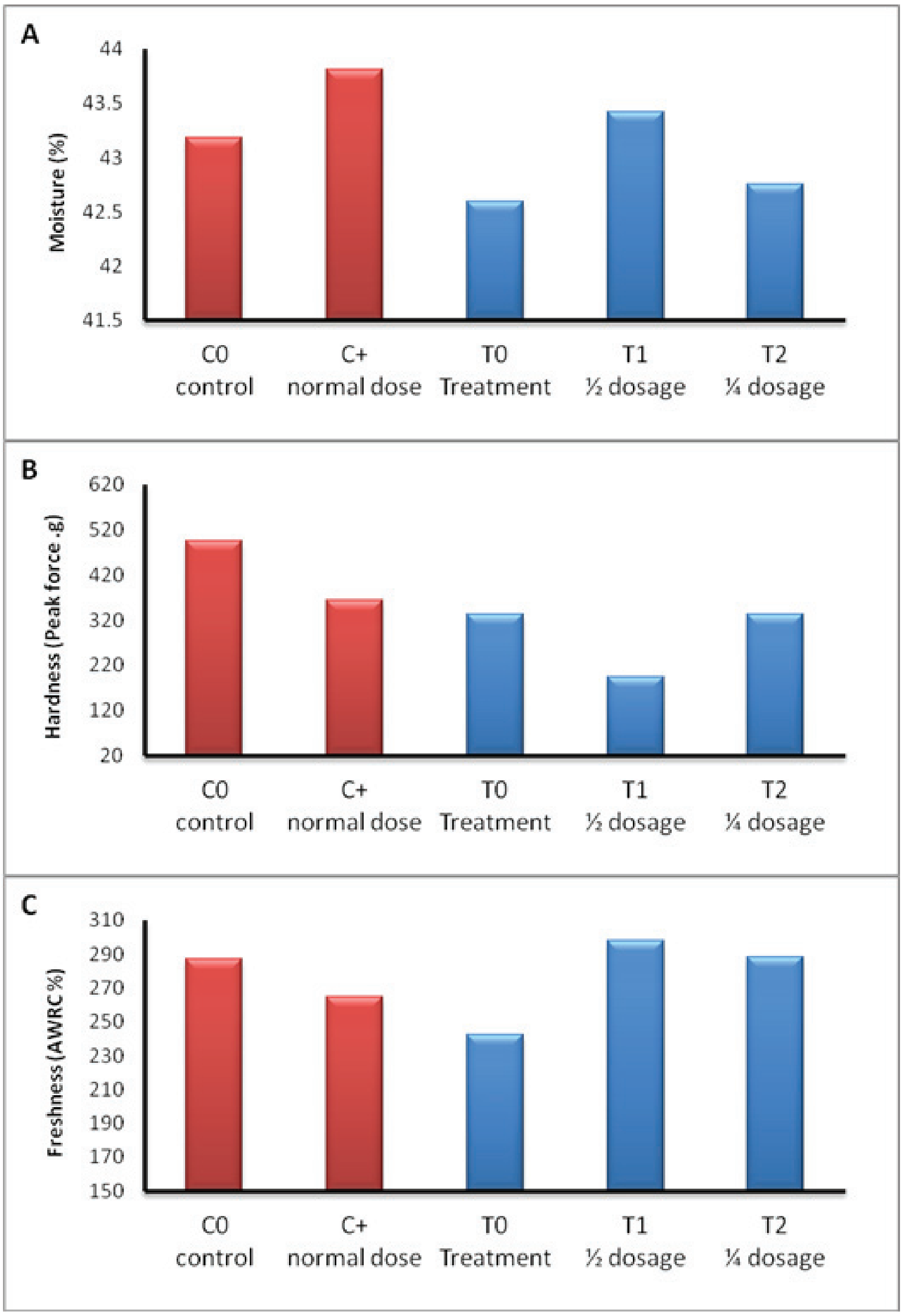

Fig. 2: Fresh crumb characteristics of pan bread made from composite flours with and without improvers

Sensory characteristics of pan bread

The data given in Table (1) and Figure (3) indicate that all sensory properties (crust and crumb colour, taste, odour, texture, cell distribution and general appearance) of pan bread made from the composite flour of selected stream blends without adding improvers (T_0) were superior than those made of composite flour of all streams or straight flours (C_0). Furthermore, adding the flour improvers to the two composite types (C^+, T_1 and T_2) led to an improvement in all the sensory properties of the produced pan bread as compared to the control composite flour bread (C_0 and T_0).

Adding the normal dose of improvers to the composite of straight flour (C_0) exhibited an improvement in its sensory characteristics (C^+). Notwithstanding, It was noted that all the sensoryproperties of the composite flour of the selected stream blends free from improvers (T_0) are still better than those of composite straight flour (C^+). It means that

Table 1: Sensory characteristics of pan bread made from the composite flours with and without improvers

Parameters	Control (C0)	Control (C+)	Treatment (T0)	Treatment (T1) 1/2 dosage (ppm)	Treatment (T2) 1/4 dosage (ppm)
Crust colour (10)	6.6	7.5	8.7	9.6	9.0
Crumb colour (10)	6.8	7.7	8.5	9.5	8.8
General appearance (10)	6.9	7.6	9.3	9.7	8.5
Taste (10)	7.0	8.4	8.3	8.5	7.9
Odour (10)	7.5	7.5	8.2	9.2	7.2
Texture (10)	6.6	7.3	8.2	9.7	8.6
Cell distribution (10)	6.6	7.5	8.8	9.6	9.1

C_0 = Composite straight flour without improvers (Control)

C^+ = Composite straight flour with adding the normal dose of improvers = (895 ppm)

The normal dose of improvers (ppm) =190 Ascorbic acid , 10 Glucose oxidase ,30 Calcium peroxide , 20 α-amylase , 30 Hemicellulase , 200 Soya , 15 Lipase , 400 Sodiumsterol lactate

T_0= composite of selected streams without improvers

T_1= composite of selected streams with added half dose of improvers (447.5 ppm)

T_2= composite of selected streams with added quarter dose of improvers (223.75 ppm)

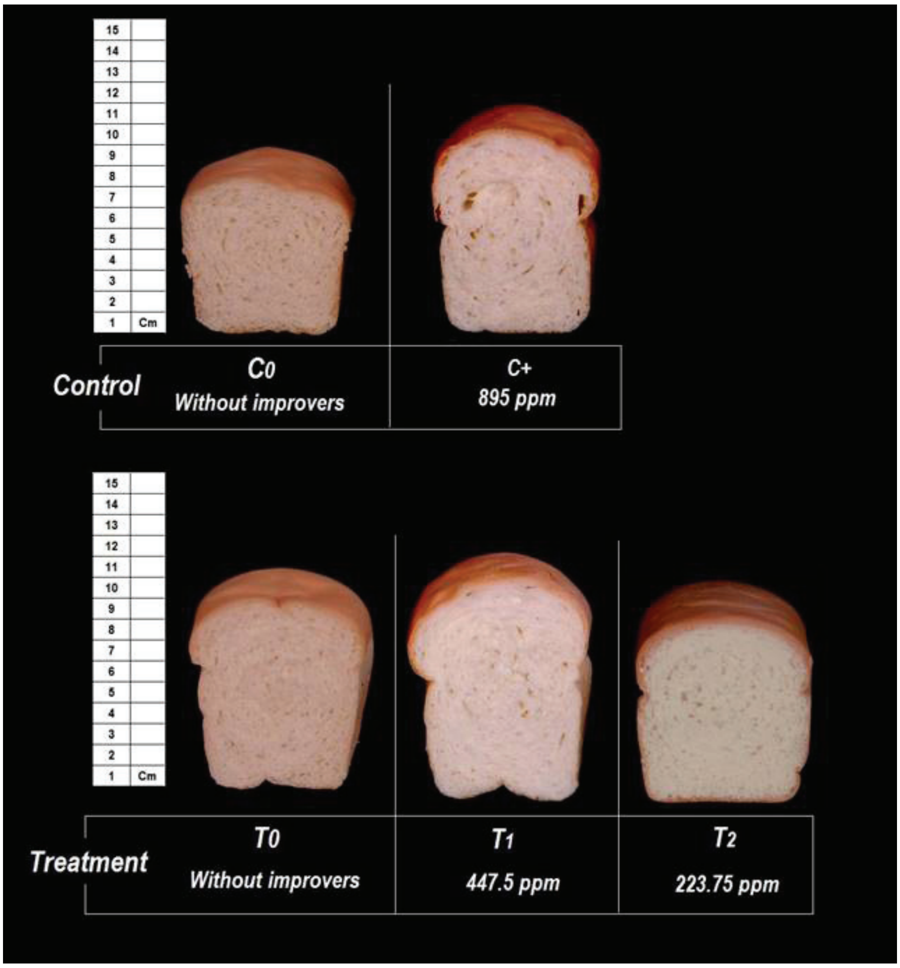

Fig. 2: Fresh crumb characteristics of pan bread made from composite flours with and without improvers

the blending process of the selected streams caused an improvement in the properties of the flour as compared with the straight composite. Moreover, it was clear that the general appearance of pan bread made from treatment (T_1) showed the highest score values given by the panelists as compared to the other treatments.

It can be concluded from the data given in Table (1) that the pan bread produced from the composite flour of selected stream blends (T_1) containing only the half dose of improvers had the superior score values of sensory characteristics. Also, it is an important point from the economic view, to reduce the added quantities of the improvers and produce high quality flour on a large scale.

Staling of pan bread

The crumb characteristics of pan bread in terms of: moisture, hardness and freshness show that the loss of the three parameters gradually increased with proceeding the storage time as given in Table (2).

The crumb moisture loss of all tested samples (C_0, C^+, T_0, T_1 and T_2) increased gradually with elongation storage time. After 6 days of storage, the loss of crumb moisture (2.58 %) from bread made from the control (T_0) of the composite of selected stream blends was lower than that (4.89%) from the composite flour of straight flour (C_0).

Regarding the effect of the improvers, adding the normal dose of improvers (895 ppm) to thecomposite straight flour (C^+) resulted in a moisture loss of 2.67%. Meanwhile, adding the flour improvers either at half dose (T_1) or quarter dose (T_2) to the composite selected stream blends resulted in moisture loss of 2.30% and 2.39%, respectively after 6 days of storage

Crumb hardness is often used as a measure of bread staling, It was observed that the crumb of bread made from a composite of straight flour (C_0) had the highest hardness (497g) (less softness) than the other treatment (T_0) (334g). Furthermore, adding half of the dose improvers (T_1) resulted in much softness (622 g) (less hardness) for the bread after 6 days of storage. Also, (T_2) which contained a quarter dose of improvers still softer than the compos-

Table 2: Crumb staling properties of pan bread made from the composite flours with and without improvers after storage for 6 days

Crumb staling properties		Control (C0)	Control (C+)	Treatment (T0)	Treatment (T1) 1/2 dosage (ppm)	Treatment (T2) 1/4 dosage (ppm)
Crumb staling	Storage time					
	Zero time	43.18	43.81	42.59	43.42	42.75
Moisture (%)	2-day	42.89	43.47	42.21	43.22	42.27
	4-day	42.74	43.28	41.84	42.74	41.85
	6-day	41.07	42.64	41.49	42.42	41.73
Hardness (Peak force g)	Zero time	497	364	334	194	334
	2-day	500	544	571	435	571
	4-day	542	617	585	467	585
	6-day	769	753	745	622	702
Freshness (AWRC %)	Zero time	287.29	264.8	242.17	298.2	288.4
	2-day	278.24	259.1	231.50	281.3	265.7
	4-day	235.16	241.5	227.07	274.8	254.1
	6-day	203.18	227.4	210.17	261.2	235.4

C_0 = Composite straight flour without improvers (Control)
C^+ = Composite straight flour with adding the normal dose of improvers = (895 ppm)
The normal dose of improvers (ppm) =190 Ascorbic acid, 10 Glucose oxidase, 30 Calcium peroxide, 20 α-amylase, 30 Hemicellulase, 200 Soya, 15 Lipase, 400 Sodium sterol lactate
T_0= composite of selected streams without improvers
T_1= composite of selected streams with added half dose of improvers (447.5 ppm)
T_2= composite of selected streams with added quarter dose of improvers (223.75 ppm)

ite straight flour (C^+) contained the normal dose of improvers which gave hardness of a value (753g).

It is clear that after 6 days of storage the hardness values of pan bread made from composite straight flours (C_0 and C^+) were higher than that made from composite flour of selected stream blends (T_0). On the other hand using half and quarter of the normal dose improved the crumb texture (reduced the harness).

The data in Table (2) indicated that, using flour improvers increased the freshness (AWRC) (decreased the loss rate of freshness) after 6 days of storage. The loss of freshness differed according to the type of composite flour. After 6 days of storage the freshness (210.17%) of pan bread made from the control of composite flour of selected stream blends (T_0) was higher than that (203.18 %) from the control of composite straight flour (C_0). It was obvious that treatment (T_1) which contained the half dose of improvers exhibited the higher freshness (261.2%). Also, adding the low level of the improvers (223.75 ppm) to the treatment (T_2) recorded a freshness value of 235.4% which was still better than treatment (C^+) which contained the normal dose of an improvers.

CONCLUSIONS

In conclusion, the amount of added improvers can be reduced to half only by using the blending process for the flour streams. Such finding means that about half of the improvers amounts can be reduced, and thereby lowering the cost of bread production. It is well known that flour improvers are imported because Egypt does not produce such ingredients.

It worth to mention that the cost of improvers added to one ton of flour is estimated at one thousand Egyptian pounds. Consequently, a reduction of improvers by 50% represents a considerable reduction in the production cost of flour.

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تأثير توليفة من دقيق طحن القمح المركب ومحسنات الدقيق على جودة خبز القوالب

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الهدف من الدراسة تحضير مخلوطان مركبان من دقيق طحن القمح، أحدهما من خلط جميع مسارات الطحن (الدقيق العادى أو الكنترول) والأخر مركب من مخلوط أفضل مساري من كل من طحن الدقيق الأسترالي و الدقيق الروسي بنسبة ١:١ واستخدامهما في انتاج خبز القوالب وتمت المقارنة بينهما فى وجود وعدم وجود محسنات الدقيق. أيضاً تم دراسة تأثير استخدام نصف وربع كمية محسنات الدقيق التي تضاف إلى الدقيق والتأثير على جودة الخبز حيث تم تقييم الخبز الناتج الطازج وبعد ٦ أيام من التخزين.

وتبين من النتائج أنه عند إضافة نصف كمية المحسنات فقط لدقيق مخلوط المسارين أدى إلى زيادة حجم الرغيف والحجم النوعي له وكانت خواص لبابة الخبز الطازج أفضل مقارنة بالخبز من الدقيق (الكنترول) الناتج من خلط جميع مسارات الطحن وفى وجود النسبة العادية (كل الكمية) المستخدمة من محسنات الدقيق.

وكانت جميع الخواص الحسية للخبز الناتج من الدقيق المركب من مخلوط المسارين المضاف اليه نصف كمية المحسنات أفضل و أكثر تقبلاً من (الكونترول) المضاف إليه كل كمية المحسنات .وأيضا إضافة نصف كمية المحسنات أو الربع أدت إلى انتاج خبز له طراوة مرتفعة وخواص عضوية حسية أفضل بعد ٦ أيام تخزين مقارنة بالدقيق الكامل والذي احتوى على الكمية الكلية من المحسنات.

والخلاصة من هذا البحث أن خلط مسارات الدقيق يؤدى الى تحسين خواص الدقيق وخواص منتجات الخبيز الناتجة. وأيضا يمكن خفض الكمية المضافة من محسنات الدقيق مما يكون له عائد اقتصادي.