Quality of Pan Bread as Influenced by Milled Flour Stream Blends of Australian and Russian Wheat

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ABSTRACT

The present study aimed to investigate the properties of some selected wheat flour mill stream blends milled on a full industrial scale and their effects on the pan bread quality. The five stream blended variants (A, B, C, D and E) were produced by blending twelve wheat flour streams by the normal milling process of two wheat types (Australian and Russian). No significant ($P \leq 0.05$) differences could be found in ash content among different stream blends of Australian wheat flour. Meanwhile, significant ($P \leq 0.05$) differences were found in ash content among those of Russian wheat flour. The stream blends B and A had the significantly ($P \leq 0.05$) highest wet gluten proportions (32.56%) and (27.81%) for Australian and Russian wheat types, respectively. Significantly ($P \leq 0.05$) higher α-amylase activity and the damaged starch contents were obtained for all different stream blends for both wheat types. The different stream blends gave a wide range of rheological properties. The longer dough stability times (20 min) and (9min) were observed for flour stream blends B and A for Australian and Russian wheat types, respectively. All pan bread made from the different flour stream blends possessed a highly significant ($P \leq 0.05$) increase in the volume than did the control (a blend of all flour streams produced from all break, divider and reduction stages). Flour stream blend B for Australian wheat and stream blend A for Russian wheat had superior parameters for the pan bread than the other flour stream blends as well as the control. It can be concluded that the monitoring of blending some flour mill streams can be used to obtain certain end-use flour quality that meets specific customer demands.

Keywords: Australian wheat, Russian wheat, flour stream blends, physiochemical and rheological properties.

INTRODUCTION

The quality and quantity of the flour produced at each break and reduction roll depends on the wheat quality. Due to the different weather conditions and their effect on wheat growing, the quality of the grain that comes into the mill is hardly ever constant. Notwithstanding, through analysis and adjustments in grain handling and blending, the miller can furnish a fairly constant product in terms of ash and protein contents and thereby controlling the quality of flour streams (Yahata *et al*., 2006). Commercial millers make up flour of specific quality by blending different kinds of flour mill streams. Blending the all resultant flour from breaking, sizing and reduction steps gives straight flour. By judiciously blending the different mill streams are obtained, the miller can produce a wide range of flours of different qualities and refinement for specific end-uses ((Wang & Flores 1999, Sakhare *et al*., 2015).Many studies have indicated that a comprehensive knowledge regarding the diversity of physicochemical and rheological properties among flour mill streams is an important issue for optimizing the final product quality ((Iuliana *et al*., 2010 , Liu *et al*., 2011, Ramseyer *et al*., 2011,Pojic *et al*., 2014).

It is worth mentioning that straight-grade flour is based on collecting all flour streams from each roll during milling and blending together. Meanwhile, patent flour is flour produced from a combination of milled fractions having similar colour and low in ash content. Also, the quality and properties of flour mill streams can be used for the monitoring of blending some flour mill streams to produce certain flour that meets specific customer demands. On the other hand, special flour is obtained by blending selected different kinds of flour mill streams for producing desired or specific quality of such end products (bread , noodles, cookies, biscuit and cakes) (Iqbal *et al*., 2015, Sakhare *et al*., 2015, Brütsch *et al.,* 2017, Abo-Deif *et al*., 2021)

The flour produced from each mill stream varies in the portion of the endosperm. So, it differs in quality, particle size, composition and function a properties. The properties of the flour mill streams can be controlled through the adjustment of roller mills and by choosing various size meshes for sieving equipment. Furthermore, blending the selected flour streams based on specific properties is the strategy to control the quality of the obtained flour. In general, wheat flour of low quality was observed as the milling yield increased especially in physicochemical properties (Wang *et al.,*2007, Kim *et al.,* 2020).

The rheological properties of dough during mixing and kneading as well as during extension reflect the differences in biochemical components present in flour mill streams (Pojic *et al*., 2014). The properties of wheat flour dough are dependent on many factors such as physical (extraction rate, particle size, damaged starch level) and chemical properties of flour (protein quality), pentosan andenzyme contents. Dough rheology determination is important for analyzing the relationship between flour quality and baked product quality.(Brütsch *et al.,* 2017).

It is worth to mention that bread volume and appearance are considered the major quality attributes of bread considered by customers. Bread-baking tests are typically used to assess hard wheat flour quality. The darkening crust colour was observed for flour breaks with progressive milling. (Leon *et al.,*2006, Kweon *et al*., 2011, Brütsch *et al.,* 2017).).

The aim of the present work is blending some flour streams obtained by the normal milling process on a full industrial scale at ideal ratios of two wheat types (Australian and Russian) to produce different flour stream blends to achieve specific properties of wheat flour differ in composition, rheological and functional properties. Also, to investigate the different properties of the prepared flour stream blends and their effects on the pan bread quality.

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 flour 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. They included five break mill streams (B1, B2, B3, B4, B5), five reduction flour fractions (C1A, C1B, C2B, C5, C6) and two divider (Div1, DiV2)(Abo-Deif *et al*., 2021).The five blended variants A, B, C, D and E were obtained from blending the twelve flour streams belonging to both wheat types (Table 1 and Fig. 1) .The obtained flour of the five stream blends was evaluated before using in pan bread production. The control is a straight flour (blend of all streams produced from all break, divider and reduction stages).

All chemicals used were of analytical grade.

Methods:

Milling process

The experimental design and the quantity of flour milled streams are given in Figure (1). The wheat samples (30 tons from each type) were cleaned and tempered to 15.5% and 16% moisture, respectively, using water at 12°C(in winter) for 36 h. The tempering was carried out in two stages: The first stage lasted 32 h, and the second stage lasted 4 h. The milling process was carried out using normal milling and controlled using an automatic programmable logic controller (PLC) system supplied by Bühler (Switzerland) at Arabian Milling and Food Industries Company, Alexandria, Egypt (Abo-Deif *et al*., 2019).

Gross chemical composition of flour mill stream blends: The near-infrared method (Inframatic 8600 Flour Analyzer) was used to determine

Table 1. Percentage ratio of individual flour mill stream and flour stream blends for Australian and Russian wheat flour types

Streams	Percentage ratio (%)		Flour stream blends				
	Australian Wheat	Russian Wheat	A	B	C	D	E
1st Break (B1)	2.62	2.39	-	-	B1	B1	-
2nd Break (B2)	2.06	2.30	-	B2	-	-	-
3rd Break (B3)	2.49	3.01	B3	-	-	B3	-
4th Break (B4)	0.82	1.07	B4	-	-	-	B4
5th Break (B5)	1.01	0.95	-	B5	B5	-	B5
1st middlings divider (DiV.1)	3.15	2.94	DiV.1	-	-	-	DiV.1
1st middlings divider (DiV.2)	2.60	2.14	-	DiV.2	-	-	-
Reduction fractions (C1A)	6.02	5.66	C1A	C1A	C1A	C1A	C1A
Reduction fractions (C1B)	2.07	1.83	C1B	-	C1B	C1B	C1B
Reduction fractions (C2B)	2.07	2.22	-	C2B	-	-	-
Reduction fractions (C5)	3.01	2.65	-	-	C5	-	-
Reduction fractions (C6)	1.96	1.5	-	-	-	C6	-
Total Percentage ratio (%)	Australian wheat		14.55	13.76	14.73	15.16	13.07
	Russian wheat		14.51	13.27	13.48	14.39	12.45

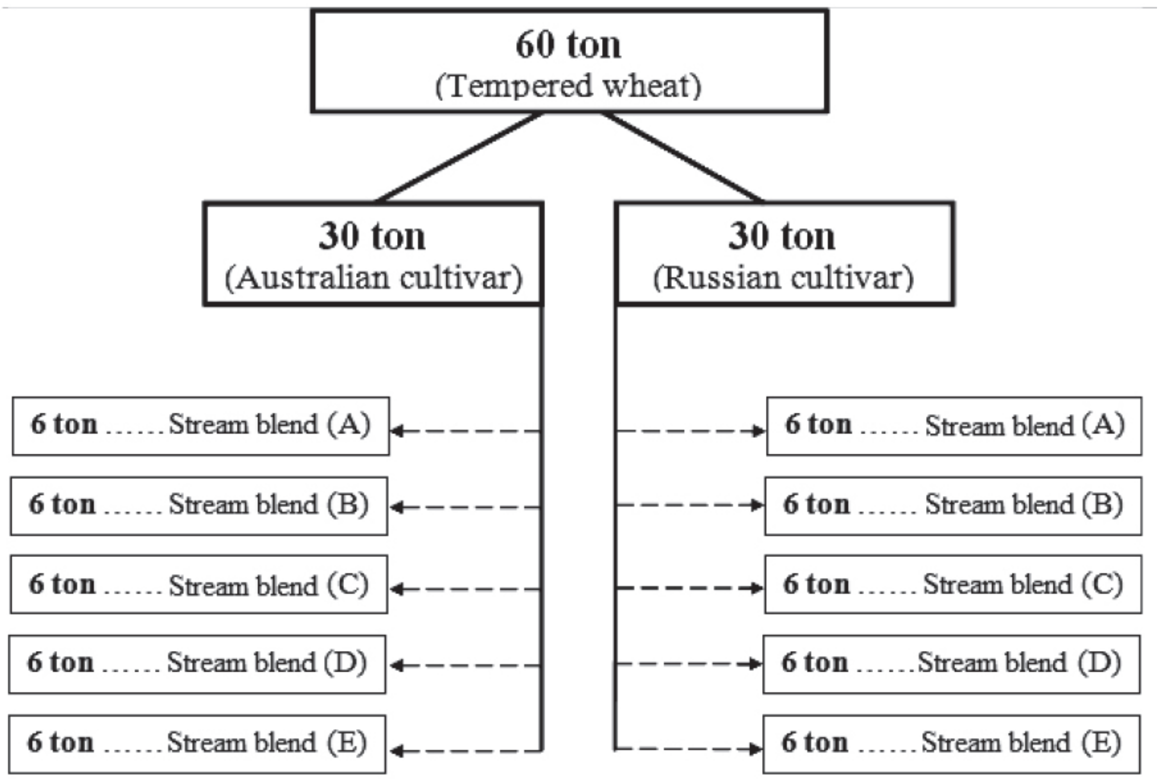

Fig. 1: Experimental design and milled wheat quantity for flour mill stream blends

the gross chemical composition (moisture, protein and ash contents) using AACCI 2000 method 08-21.01. The lipid content was determined according to AACCI 2000 method 30-25.1. The proportion of total carbohydrates was calculated by difference (method 44-11.01).

Damaged starch, falling number, and gluten parameters: A Chopin SD matic was used to determine the damaged starch content of flour according to the Approved AACCI 2000 (method 76.33.1). The falling number 1500 system (α-amylase activity) was determined according to AACCI 2000 method 56-81.03. The gluten properties were determined using a Glutomatic Perten Instruments AB type 2200 system (Huddinge, Sweden) according to AACCI 2000 method 38-12.02.

Rheological properties (Alveograph and Mixolab Simulator): The rheological properties of flour were determined by a Chopin alveograph according to AACCI 2000 method 54-30.02 and Mixolab simulator (Chopin, Tripette and Renaud) according to the AACCI 2000 method 54-60.01 and the ICC 2006 method 173.

Pan bread processing

The straight dough process (El-Porai, *et al.,* 2013) was performed to prepare pan bread from stream blends. The formula was as follows: 100 g wheat flour, 1.5 g instant active dry yeast, 2.0 g salt, 2.0 g sugar, 3.0 g shortening and water (according to the water absorption capacity indicated by the Mixolab simulator). The prepared dough (75 g) was proofed for 80 min in a cabinet at 30± 0.5 °C and 85 % relative humidity. Baking was carried out for 20 min at 180°C in an electrical oven (a one-circuit Miweecono oven). The baked bread was cooled for 60 min at room temperature (25± 2.0 °C) and then packed in polyethylene bags.

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 method AACCI 2000 method 10-05.01. The specific volume (cm^3/g) of bread was calculated by dividing the volume by the weight.

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).

Statistical analysis.

A split-split plot design was used according to Gomez & Gomez (1984).The main plots were assigned to the two wheat cultivars, Australian and Russian, the sub-plots included the normal milling system. SAS (Statistical Analysis System) ver. 8.1, 2001, was used for all statistical computations. The LSD values were used to compare the different combinations of whole plots and subplots. All statistical tests were carried out at a significance level of $P \leq 0.05$. All experiments were performed in three sets of duplicates.

RESULTS AND DISCUSSION

Generally , most of the obtained data here illustrated that the properties of the obtained flour stream blends depended on the milling stage (break, reduction, dividing), flour type used in the blends, sequence of flour streams in the same stage and the proportion or quantity of flour streams used in the blends either from Australian or Russian wheat.

Proximate chemical composition

The results in Table (2) indicate that the type (break, reduction, dividing), sequence and proportion of flour streams used in preparing the different Australian stream blends (A to E) had significant ($P \leq 0.05$) effects on the chemical composition of the obtained flour stream blends. The highest moisture content (14.10%) and (13.23%) were obtained from flour stream blends D and A, for Australian and Russian wheat types, respectively. Meanwhile, stream blend C gave the lowest moisture content for the two wheat types. This can be attributed to these stream blends D and A containing flour stream "B3" fraction, whereas the stream blend C contained B5, as the grinding progressed from B1 to B5 which caused a decrease in the moisture content. Consequently, significant ($P \leq 0.05$) differences could be found in moisture content among the different stream blends.

No significant ($P \leq 0.05$) differences could be found in ash content among different stream blends of Australian wheat flour (Table 2). This can be explained on the basis that most stream blends contained both C1A and C1B 'fractions or streams extracted or separated from the central endosperm, which are characterized by lower ash content

Table 2. Proximate chemical composition of different flour stream blends for Australianand Russian wheat types*

Parameters	Milling stage	Stream blends					Control	LSD
		A	B	C	D	E		
	Break	B3, B4	B2, B5	B1, B5	B1, B3	B4, B5		
	Divider	DiV1	DiV2	-	-	DiV1		
	Reduction	C1A ,C1B	C1A ,C2B	C1A ,C1B , C5	C1A ,C1B , C6	C1A ,C1B		
Australian wheat								
Moisture (%)		13.71^{cd}	13.76^{bc}	13.57^{d}	14.10^{a}	13.90^{b}	14.23^{a}	0.17
Ash (%)		0.61^{a}	0.61^{a}	0.63^{a}	0.60^{a}	0.63^{a}	0.62^{a}	0.03
Protein (%)		12.92^{b}	12.70^{c}	12.52^{d}	12.65^{cd}	12.64^{cd}	14.32^{a}	0.16
Fat (%)		0.91^{e}	1.11^{cd}	1.42^{a}	1.19^{c}	1.05^{d}	1.31^{b}	0.09
Total carbohydrates (%)		85.56^{b}	85.56^{b}	85.43^{c}	85.56^{b}	85.68^{ab}	83.75^{a}	0.12
Russian wheat								
Moisture (%)		13.23^{b}	12.79^{c}	12.35^{e}	12.56^{d}	12.44^{de}	13.49^{a}	0.15
Ash (%)		0.63^{bc}	0.62^{c}	0.62^{c}	0.66^{a}	0.64^{abc}	0.65^{ab}	0.02
Protein (%)		10.81^{c}	11.05^{b}	10.42^{d}	10.80^{c}	10.52^{d}	12.71^{a}	0.23
Fat (%)		0.86^{d}	1.06^{ab}	1.09^{a}	1.01^{bc}	0.97^{c}	1.02^{abc}	0.07
Total carbohydrates (%)		87.70^{b}	87.27^{d}	87.87^{a}	87.53^{c}	87.88^{a}	85.62^{e}	0.13

Values followed by the same letter in the same row are not significantly different *($P \leq 0.05$)*.

*normal milling at 12°C tempered for 36 h. Total carbohydrate content was calculated by difference. control: a blend of all flour streams produced from the break, divider and reduction stages.

The results were calculated on a dry weight basis

(0.52%). For Russian wheat flour,significant ($P \leq 0.05$) differences could be noted in ash content among the different stream blends. The lowest ash content (0.62%) was obtained for stream blends B and C comparable to the control flour (0.65%) which was produced from streams of all break, divider and reduction stages. This may be attributed to these blends mostly consist of the C1A, C1B and C5 fractions (Table 2).

Also, the data given in Table (2) indicate that there are little variations in the protein content among the different stream blends of Australian wheat flour. The highest .significantly ($P \leq 0.05$) protein content (12.92 %) was obtained for blend A comparable to other stream blends. This is due to this stream blend A containing B3 and B4 fractions or streams from the ventral and dorsal endosperm, which are both characterized by higher protein content. Among the different stream blends of Russian wheat flour, a significantly ($P \leq 0.05$) higher protein content (11.05 %) was obtained from stream blend B.This is due to this stream blend containing the B2 fraction which has the richest protein content (Table 2).These results agree well with those reported by Iuliana *et al*., (2010). They found that the protein content increase as the number of breaks (B1–B4) increases.

Significant ($P \leq 0.05$) differences could be observed in the fat content of the different stream blends. The data revealed that stream blend C gave significantly ($P \leq 0.05$) the highest fat content for the two wheat types comparable to the other stream blends and the control flour. This is due to stream blend C mostly consist of grinding progressed break and reduction streams B5 and C5 which are the richest in fat content The streams formed in the later reduction passes have higher content of lipids (Iuliana *et al*., 2010).

Also, significant differences were observed in the carbohydrate contents of different stream blends. The results presented here indicate that stream blend E gave significantly ($P \leq 0.05$) higher carbohydrate content (85.68%) comparable to the other stream blends for Australian wheat. Meanwhile, stream blends C and E gave significantly ($P \leq 0.05$) higher total carbohydrate contents (87.87

and 87.88%), respectively comparable to the control flour for Russian wheat.

Physicochemical characteristics

Gluten quantity

The wet and dry gluten content of the different Australian flour stream blends were significantly ($P \leq 0.05$) affected by the type, proportion and sequence or number of included flour streams. The wet gluten of all stream blends was higher than that in the control flour as shown in Figure (2). For Australian wheat, the stream blend B had the highest wet gluten proportion (32.56%), this mostly contained the B5, C2B and DiV2 fractions, which are characterized by higher wet gluten proportions. Meanwhile, for Russian wheat the wet gluten (27.81, 27.56 and 27.74%) was significantly ($P \leq 0.05$) higher for the stream blends A, B and D, respectively. It is worth to mention that these blends consist of flour streams which are characterized by higher wet gluten proportions such as B3, B4, B5, DiV2, C2B and C6.

For Australian wheat, the highest values (11.11 and 11.01, 11. 06%) of dry gluten content were

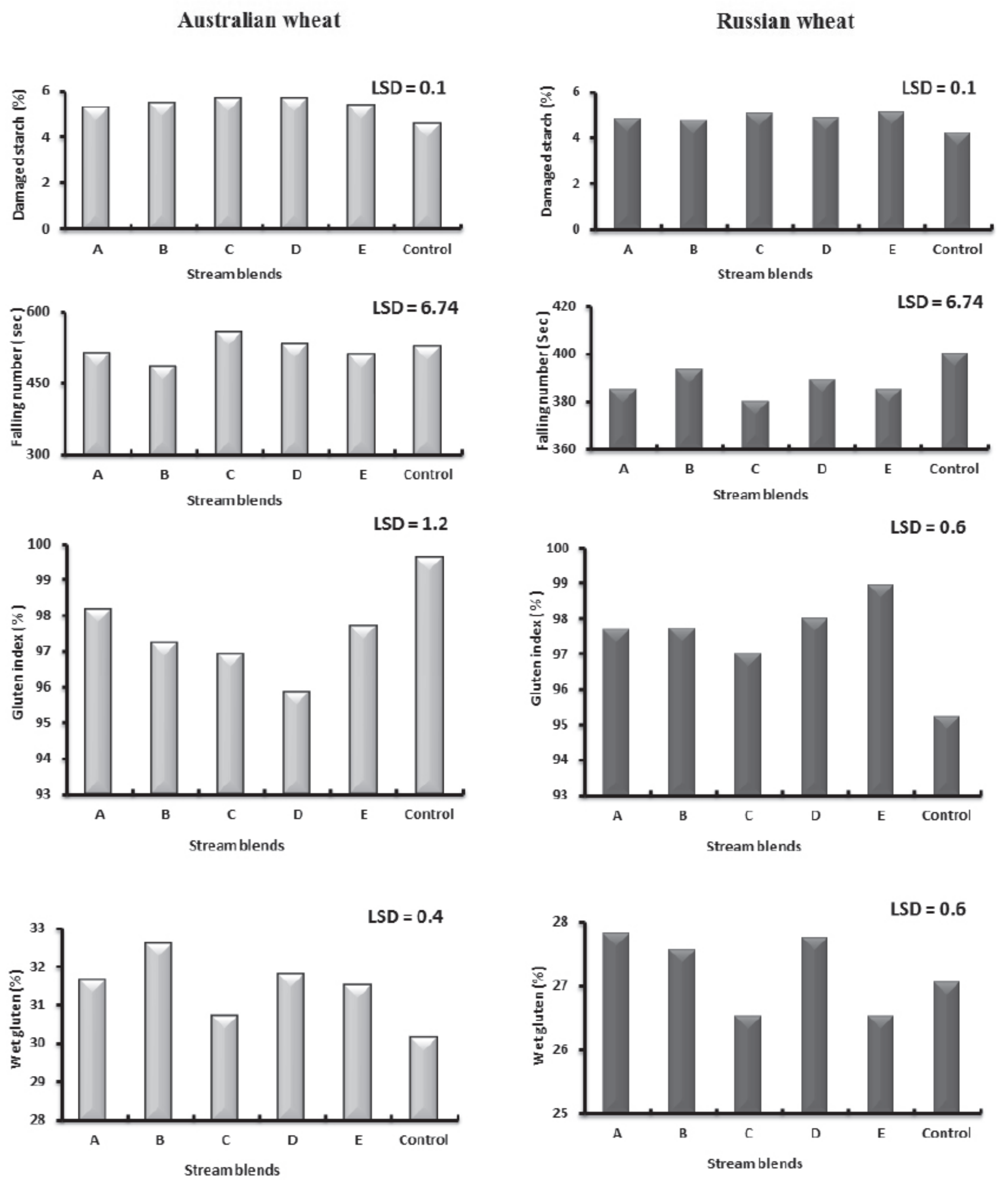

Fig. 2. Physicochemical characteristics of flour stream blends for Australian and Russian wheat

recorded for the flour stream blends A, B and E, respectively. It is worth to mention that no significant ($P \leq 0.05$) differences could be found between these three stream blends and the control (11.06 %). For Russian wheat, a higher value (9.74 %) was recorded for stream blend B comparable to the control flour (9.05). No significant ($P \leq 0.05$) differences could be found between the other stream blends and the control

Gluten index

Among the different flour stream blends obtained from the Australian wheat, the gluten index of stream blend A recorded the highest level (98.17%) (Fig. 2). In contrast the lowest ones (96.93 and 95.87%) were recorded for stream blends C and D, respectively. This may be attributed to the type of flour streams used in these blends. These blends mostly consist of grinding progressed break flour stream (B5) and reduction flour streams (C5 and C6) which are considered the richest in fat and ash content. Whereas, for Russian wheat, the stream blend E gave the highest gluten index (98.97%). This can be attributed to this blend containing flour streams coming from the peripheral zone of the kernel mainly B4 and DiV1 which are characterized by a high gluten index. These results are in agreement with the published data by Brütsch *et al*., (2017), who reported that the presence of high fat and ash in flour (bran particles) can interfere with gluten network formation and thereby weaken it.

Gluten water binding capacity

No significant ($P \leq 0.05$) differences could be observed for water binding capacity between the different flour stream blends and the control flour for the two types of wheat under study.

Falling number

The lower significant ($P \leq 0.05$) falling number (483 sec) was figured out by the stream blend B for the Australian wheat flour because it contained B5 and DiV2 fractions. These are characterized by lower falling number values. Significantly ($P \leq 0.05$) higher α-amylase activity was obtained for all different flour stream blends (falling number ranged from 380 to 393 sec) for the Russian wheat flour comparable to the control flour (falling number 400 sec) (Fig. 2). Notably, all these blends mostly consist of fractions coming from the ventral and dorsal endosperm (B1 to B4 and DiV1) which has a lower falling number.

Damaged starch

The results shown in Fig. (2) show that the damaged starch values for all stream blends obtained from the two types of wheat were higher than that of the control flour. The highest levels of damaged starch (5.58 and 5.60%) were found for stream blends C and D,while 5.07 and 5.10% were obtained from stream blends C and E, for Australian and Russian wheat flour, respectively. These blends mostly consist of fractions characterized by higher levels of damaged starch. Sakhare*et al*., (2015) mentioned that more severity of grinding in the reduction rollers leads to producing flour containing higher damaged starch values than of break ones.

Alveograph properties of stream blends

Figures (3) and (4) presented the alveograph parameters (elasticity, extensibility, elasticity/ extensibility ratio, swelling index, elasticity index and deformation energy) for the dough of different flour stream blends for both types of wheat.

For dough elasticity (P), the results show that the different stream blends produced from Australian wheat flour gave lower values of dough elasticity comparable to that of the control flour. Among the stream blends the highest dough elasticity (110 and 111 mm) was obtained from stream blends A and C, respectively (Figure 3). These blends are mostly composed of the flour streams C1B and C5 which are characterized by higher dough elasticity (124 mm for C1B and 130 mm for C5).

It is clear that the flour stream blends produced from Russian wheat gave a wide range of dough elasticity (Figure 4). The highest dough elasticity (102 mm) was obtained for stream blend C. It consists of fractions C1A, C1B and C5 which are characterized by high elasticity. On the other hand, the lowest value (93 mm) was obtained for stream blend A which consists mainly of fractions B3, B4 and DiV1 which are characterized by lower dough elasticity.

For dough extensibility (L), the results show that the different flour stream blends obtained from Australian wheat gave a wide range of dough extensibility (Figure 3). Both the stream blends A and D recorded higher values (143 and 141 mm) than the control flour (139 mm) and the other flour stream blends. These blends mostly consist of the flour streams B4 and B5 which are characterized by higher dough extensibility (231 mm for B4 and 347 mm for B5).

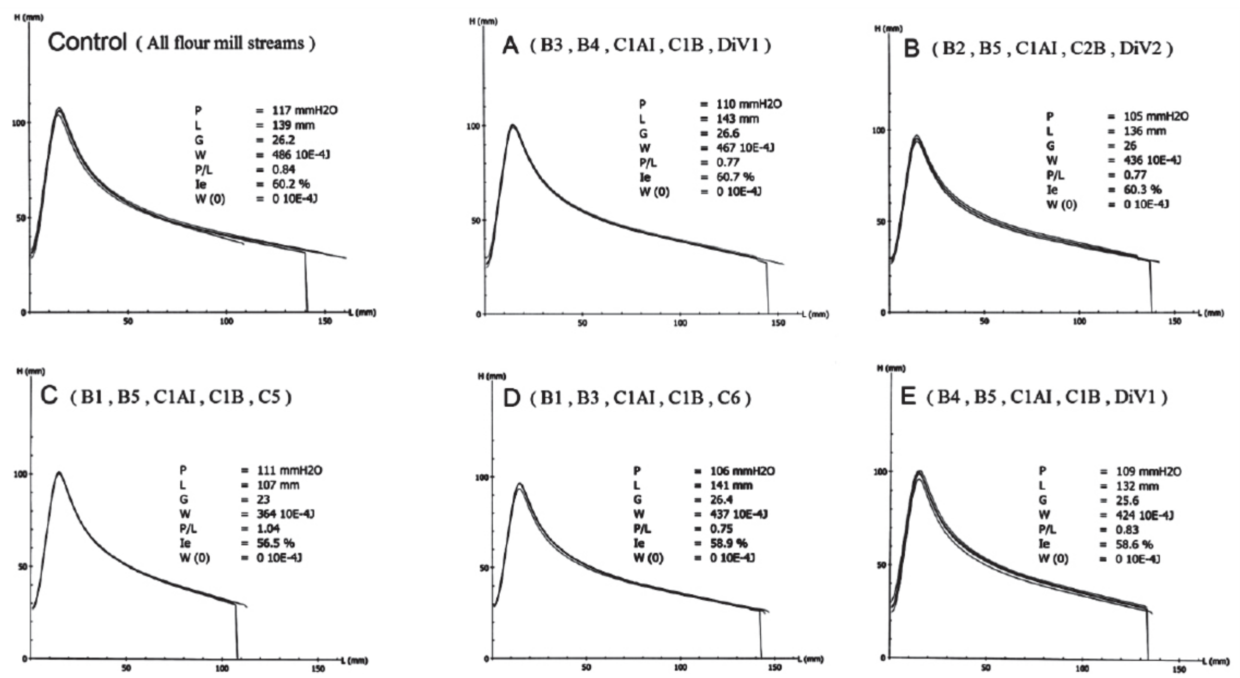

Fig. 3. Alveograph parameters of dough from the different flour mill stream blends from Australian wheat *

P: maximum pressure (mm); L: extensibility (mm); P/L: balance between tenacity and extensibility;
G: swelling; Ie: elasticity index; W: deformation energy (10−4 J)

*normal milling at 12°C, tempered for 36 h. control: a blend of all flour streams produced from the break, divider and reduction stages.

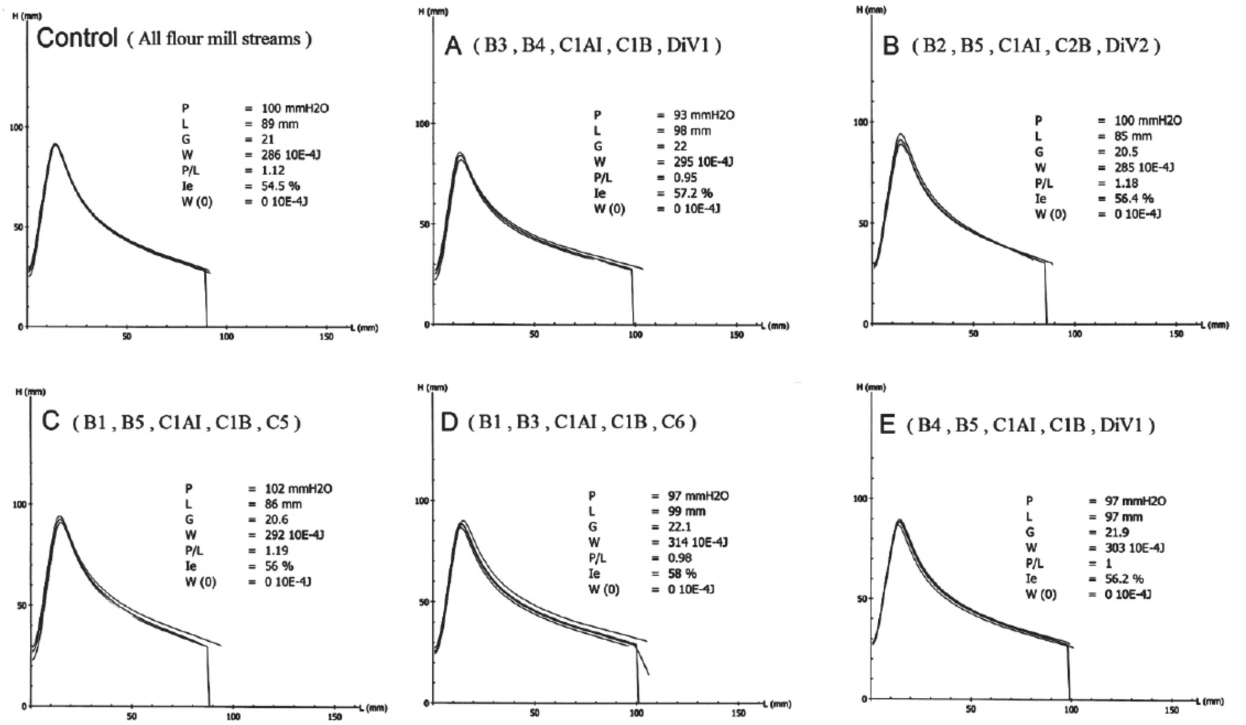

Fig. 4. Alveograph parameters of dough from the different flour mill stream blends from Russian wheat*

P: maximum pressure (mm); L: extensibility (mm); P/L: balance between tenacity and extensibility;
G: swelling; Ie: elasticity index; W: deformation energy (10−4 J)

*normal milling at 12°C tempered for 36 h. control: a blend of all flour streams produced from the break, divider and reduction stages.

The data in Figure (4) show higher values (98, 99 and 97 mm) for dough extensibility of stream blends A, D and E, respectively obtained from Russian wheat comparable to the control (89 mm). These blends are containing the break flour streams B3 to B5 which had higher dough extensibility.

The curve configuration ratio (P/L ratio) ranged from 0.75 to 1.04 for different flour stream blends produced from Australian wheat (Figure 3). The optimum ratio P/L (1.04) was achieved by stream blend C. This may be attributed to this blend mostly consists of each part of the wheat kernel, from the ventral and dorsal endosperm (B1, B5 and C5) and central endosperm (C1A and C1B).

It was obvious that the P/L ratio was improved by selected stream blends obtained from Russian wheat flour comparable to the control flour (1.12) (Figure 4). These results of the optimum balance between dough elasticity and extensibility (P/L, 0.95, 0.98 and 1) were obtained by stream blends A, D and E,respectively. It is worth to mention that these blends were composed of flour streams, DiV1 and C6 which had the optimum P/L ratio.

A wide range of swelling index (G) and elasticity index (Ie) was found for the different stream blends produced from Australian wheat (Figure 3). The highest values of swelling indices (26.6, 26 and 26.4) and elasticity indices (60.7, 60.3 and 58.9 %) were obtained by the three stream blends A, B and D, respectively. These blends are mainly consisting the latest break streams (B3 to B5) and divider streams (DiV1 and DiV2), which had higher dough extensibility (L).

For swelling index (G) and elasticity index (Ie), stream blends A, D and E obtained from Russian wheat recorded the highest values comparable to the control flour (21 for swelling index and 54.5 for elasticity index) Figure (4).The aforementioned values were 22, 22.1 and 21.9, for the swelling index and 57.2, 58 and 56.2, for the elasticity index, respectively. Such an effect can be explained on the basis that these blends are mainly consisting the latest break streams (B3 to B5) and divider streams (DiV1 and C6), which are characterized by higher dough extensibility

As shown in Figure (3), the deformation energy (W) of all different stream blends of Australian wheat gave lower values comparable to that of the control flour. Among the different blends, stream blends A gave the highest value (467) comparable to the other stream blends. This blend mostly consists of flour streams which are characterized by higher dough elasticity (P) and extensibility (L).

Deformation energy (W) was improved for stream blends of Russian wheat comparable to the control Figure (4). Most of the stream blends gave higher values comparable to the control. These results show that stream blend D gave the highest deformation energy (314) comparable to the other stream blends. These blends are mostly composed of the fraction B3 which is characterized by higher dough elasticity (P) and extensibility (L).

It can be concluded from the previous results that the Alveograph parameters of all the stream blends of Australian and Russian wheat flour were much better than those of the control flour.

Mixolab simulator characteristics of stream blends

Mixolab parameters of the different stream blends produced from Australian and Russian wheat flour are presented in Table (3)

The different flour stream blends gave a wide range of dough development time (DT). The longest DT (6 min) was obtained for stream blend A for Australian wheat flour. Because this blend mostly consists of the fractions (B3,B4 and DiV1) which are characterized by longer DT (6 min for B3, 6.5 min for B4 and 5.5 min for DiV1). Meanwhile, it was 3 min for blend B for Russian wheat flour.

The farinographic parameters such as water absorption and dough development time increased with an increase in flour extraction rate(Aprodu *et al* 2010,Mueen-ud-Din *et al.,* 2010). Moreover, the elongation of development time was attributed to the effect of the interaction between fibers and gluten that prevents the hydration of the proteins, affecting the aggregation and disaggregation of the high molecular weight proteins in wheat (Moradi *et al*., 2016).

Stability time (ST) is an important index for dough strength based on the quality and quantity of dough gluten. Accordingly, it was observed that the stream blends gave a wide range of dough stability. The longer ST times (18.5, 20 and 20.5 min) were found for stream blends, A, B and C, respectively for Australian wheat flour, as compared to that of the control flour (16 min). These blends are composed of fractions which are characterized by longer dough stability (17 min for B3, 13.5

Table 3. Mixolab simulator parameters of dough from the different flour stream blends for Australian and Russian wheat types*

Parameters	Milling stage	Stream blends					Control
		A	B	C	D	E	
	Break	B3, B4	B2, B5	B1, B5	B1, B3	B4, B5	
	Divider	DiV1	DiV2	-	-	DiV1	
	Reduction	C1A, C1B	C1A, C2B	C1A, C1B, C5	C1A, C1B, C6	C1A, C1B	
Australian wheat							
DT: development time (min)		6	4	4.5	5.5	4.5	6
ST: stability time (min)		18.5	20	20.5	14.5	12.5	16
Weakening (Farinograph units)		13	25	17	20	28	17
WA: water absorption (%)		60	59.9	60.1	61	60.7	60.6
DT: development time (min)		6	4	4.5	5.5	4.5	6
Russian wheat							
DT: development time (min)		2.5	3	2.5	2	2	3
ST: stability time (min)		9	8.5	7.5	7	6	8
Weakening (Farinograph units)		45	38	49	44	56	48
WA: water absorption (%)		58.5	58.5	58.2	58.3	58.9	58.3
DT: development time (min)		2.5	3	2.5	2	2	3

*normal milling at 12°C, tempered for 36 h, control: a blend of all streams

min for B4, 22.5 min for B5, 20 min for DiV1, 19 min for C1B and 20.5 min for C2B). For Russian wheat flour, The highest ST (9 min) was found by stream blend A comparable to the control (8 min). This stream blend mostly consists of flour streams which had longer dough stability (14 min for B3, 15.5 min for B4 and 9 min for DiV1).

The stability value is an indication of the flour's strength, with higher values suggesting stronger dough. The dough containing less bran exhibited more stability than the other samples (Moradi *et al.*, 2016, Brütsch *et al.*, 2017)

Concerning the degree of weakening, lower degrees of weakening (13 and 17 FU) were noted for stream blends A and C of Australian wheat flour, and (38 FU) for stream blend B of Russian wheat flour(Table 3). These blends consist of fractions B2, B3, B4 and DiV2 which are characterized by the higher gluten index.

Furthermore, for water absorption, the data presented here show that the highest ratio (61%) was recorded for stream blends D and E for Australian and Russian wheat flour, respectively comparable to the control. Generally, these results may be due to the properties of flour streams composed of these blends.

Physical properties of pan bread

The data obtained here revealed that the loaf parameters of all pan bread were highly significantly ($P \leq 0.05$) affected by the type of flour stream blends compared to the control flour. All pan bread made from different Australian stream blends possessed a strongly significant ($P \leq 0.05$) increase in pan bread volume as compared to the control flour. The highest volumes (1245 cm^3) and (990 cm^3) were given by stream blends B and A for Australian and Russian wheat, respectively (Fig. 5). This is due to the longer dough stability time, higher wet gluten and a higher level of damaged starch (5.41%). El-Porai *et al.,* (2013) found that the highest loaf volume of pan bread was related to higher values of wet gluten, gluten index and dough stability time. Also, they found that using flour low in both damaged starch and enzyme activity for pan bread making, resulted in dough having low ability of gas retention and consequently low volume bread.

It was noted that there were slight differences in the loaf weights of all pan bread made from the different flour stream blends and those made from the control flour.

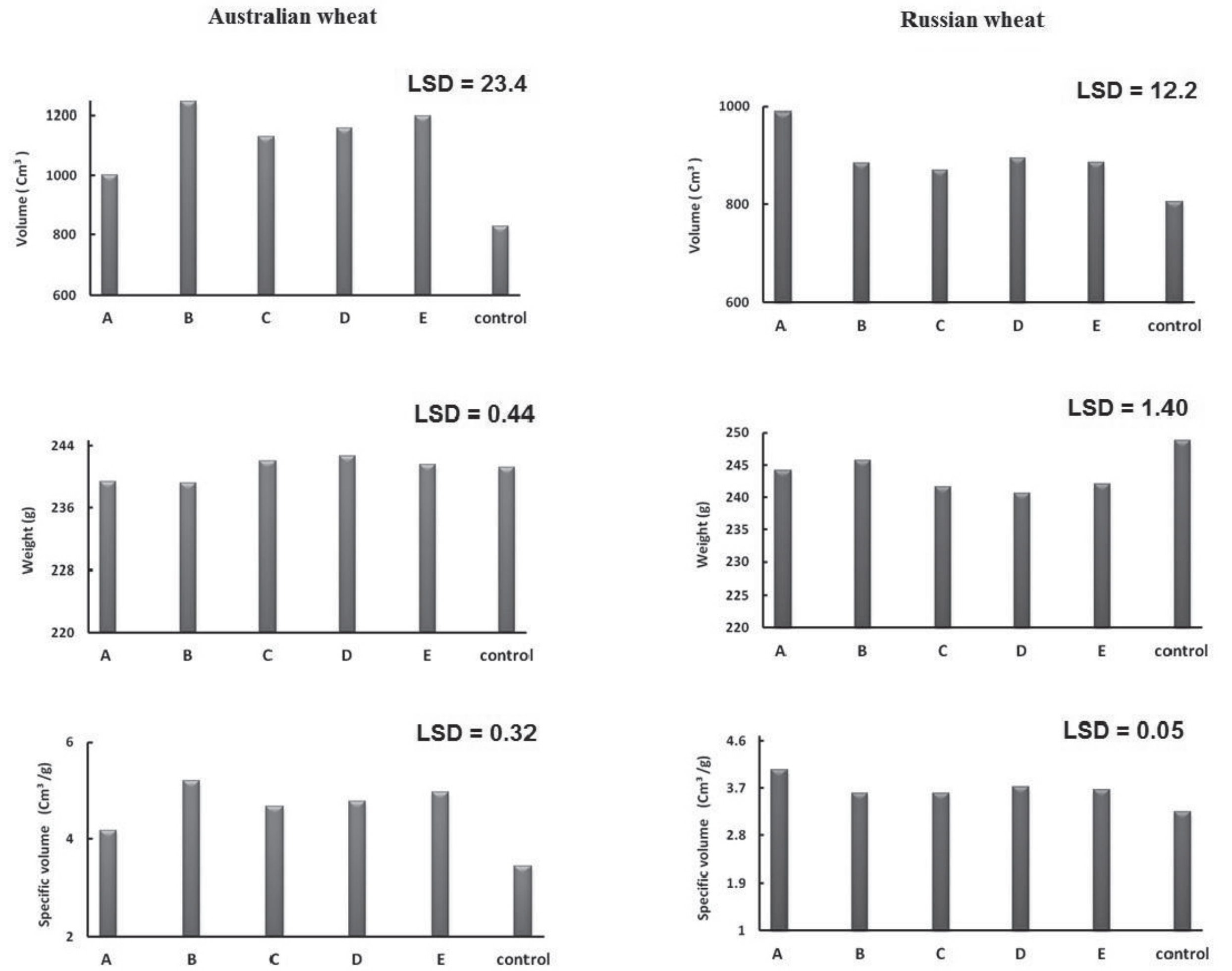

Fig. 5. Physical properties of pan bread made from the flour stream blends and straight flour (control) of Australian and Russian wheat types.

Control: a blend of all flour streams produced from the break, divider and reduction stages.

Concerning the specific volume, the data given in Figure (5) indicate that all selected stream blends produced pan bread had a strongly significant ($P \leq 0.05$) increase in specific volume ranging between 4.18 and 5.2 cm³/g as compared to the control flour being 3.43 cm³/ g. The highest specific volumes (5.20 cm³/g) and (4.05 cm³/g) were recorded forstream blends B and A for Australian and Russian wheat flour, respectively. This may be attributed to their higher α-amylase activity. Wheat flour with a higher level of α-amylase activity (lower falling number) gave pan bread of highly significant ($P \leq 0.05$) specific volume (El-Porai *et al* .,2013) . Also, Brütsch *et al.* (2017) reported that the degree of damaged starch and wet gluten content are the major factors affecting the flour levels and bread characteristics.

From the previous results, it can be concluded that the pan bread produced from stream blends Band A for Australian and Russian wheat types, respectively, had better parameters than the other stream blends and the control.

Sensory characteristics of pan bread

The data in Table (4) indicate that pan bread made from the different types of Australian and Russian stream blends gave significantly ($P \leq 0.05$) higher sensory bread qualities as compared to the control flour.

The dark crust colour was observed for stream blends consisting the latest break fractions B4 and B5. These data are in accordance with those obtained by Brütsch *et al*., (2017). They stated that a darkening crust colour was observed for flour breaks with progressive milling. The sensory scores for taste and odour indicate that all flour stream blends recorded significantly ($P \leq 0.05$) higher scores than the control flour. Texture and

Table 4: Sensory characteristics of pan bread made from the flour stream blends of Australian and Russian wheat types*

Parameters	Stream blends					Control	LSD
Milling stage	**A**	**B**	**C**	**D**	**E**		
Break	**B3, B4**	**B2, B5**	**B1, B5**	**B1, B3**	**B4, B5**	**All flour streams**	
Dividing	**DiV1**	**DiV2**	**-**	**-**	**DiV1**		
Reduction	**C1A, C1B**	**C1A, C2B**	**C1A, C1B, C5**	**C1A, C1B, C6**	**C1A, C1B**		
Australian wheat							
Crust colour (10)	7.9^{c}	8.7^{ab}	8.9^{ab}	8.2^{bc}	9.3^{a}	8.5^{bc}	0.8
Crumb colour (10)	9.4^{a}	7.8^{cd}	9.0^{ab}	8.1^{cd}	7.3^{d}	8.3^{bc}	0.8
General appearance (10)	8.3^{bc}	9.7^{a}	8.9^{ab}`	7.5^{c}	7.4^{c}	7.8^{c}	1
Taste (10)	8.3^{ab}	8.0^{bc}	8.8^{a}	8.6^{ab}	7.9^{bc}	7.4^{c}	0.7
Odour (10)	8.2^{bc}	8.7^{ab}	8.4^{b}	8.1^{bc}	9.3^{a}	7.5^{c}	0.7
Texture (10)	8.8^{a}	7.4^{c}	7.7^{bc}	8.4^{ab}	8.7^{a}	8.4^{ab}	0.8
Cell distribution (10)	8.2^{b}	7.2^{c}	8.0^{b}	8.2^{b}	9.5^{a}	9.5^{a}	0.8
Russian wheat							
Crust colour (10)	8.5^{a}	8.1^{a}	6.5^{b}	7.2^{b}	8.1^{a}	7.1^{b}	0.8
Crumb colour (10)	8.4^{a}	7.0^{bc}	7.4^{b}	7.4^{b}	6.5^{c}	8.4^{a}	0.7
General appearance (10)	8.9^{a}	7.3^{c}	6.3^{d}	8.1^{b}	7.4^{bc}	7.6^{bc}	0.8
Taste (10)	8.7^{a}	7.7^{bc}	6.3^{d}	7.6^{c}	7.6^{c}	8.3^{abc}	0.9
Odour (10)	8.2^{ab}	7.6^{bc}	8.1^{abc}	8.3^{ab}	8.5^{a}	8.1^{ab}	0.9
Texture (10)	7.7^{c}	8.0$^{.bc}$	7.0^{c}	8.9^{a}	6.7^{d}	8.8^{ab}	0.8
Cell distribution (10)	8.0^{ab}	8.2^{ab}	7.4^{bc}	8.7^{a}	6.8^{c}	8.3^{a}	0.8

Values followed by the same letter in the same row are not significantly different ($P \leq 0.05$).
*normal milling at 12 °C, tempered for 36 h
Control: a blend of all flour streams produced from the break, divider and reduction stages.

cell distribution of pan bread loaves exhibited wide differences for the different stream blends.

For general appearance, the pan bread from stream blends B and A had significantly ($P \leq 0.05$) the highest scores (9.7) and (8.9) for Australian and Russian wheat types, respectively as compared to the control flour. Also, the highest volume and the highest specific volume were given by stream blends B and A for the Australian and Russian wheat, respectively.

From the previous results, it can be concluded that the pan bread produced from stream blends Band A for Australian and Russian wheat types had superior parameters than the other stream blends as well as the control flour.

CONCLUSIONS

It can be concluded that blending some selected flour mill streams based on specifics or desired properties can produce a variety of high flour grades. Moreover, the baking properties of the produced flour can be enhanced by blending some flour mill streams to meet specific customer demands such as producing pan bread of high quality.

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جودة خبز القوالب وتأثرها بمخاليط مسارات طحن دقيق القمح الاسترالي والروسي

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الهدف هو دراسة خواص الدقيق الناتج من خلط دقيق بعض مسارات الطحن لكل من نوعين من القمح (الاسترالي والروسي) وتأثيرها على جودة خبز القوالب. تم توليف خمس خلطات من دقيق مسارات الطحن لكل من نوعى القمح من اثنى عشر مسار الناتج من الطحن بالطريقه العادية على نطاق صناعى وأعطت الحروف(A-B-C-D-E).

واتضح من النتائج أنه لا يوجد اختلافات معنويه فى محتوى الرماد فى دقيق مخلوط مسارات القمح الأسترالى بعكس القمح الروسى الذى وجد فى محتواه من الرماد اختلافات معنوية. وتبين أن مخلوطا الدقيق A، B يحتويان على أعلى نسبة من الجلوتين (٣٢,٥٦، ٢٧,٨١٪) فى دقيق القمح الأسترالى والروسى على الترتيب. وأيضا كانت نسبة كل من نشاط أنزيم الأميلاز والنشا المحطم مرتفعة فى جميع مخاليط الدقيق لنوعي القمح بالمقارنة بالعينة الضابطة (الكونترول).

بالنسبة للصفات الريولوجية كان أعلى زمن ثبات للعجين (٢٠، ٩ دقيقة) لدقيق مخلوط A، B القمح الأسترالى والروسى على الترتيب. وأوضحت نتائج الخواص الوظيفية لخبز القوالب المصنع من دقيق المخاليط الخمسة أن خبز المخلوط (B) سجل أعلى حجم للرغيف وأعلى حجم نوعي وأفضل خواص حسية بالنسبة لمخاليط مسارات طحن القمح الأسترالي . بينما القمح الروسي سجل مخلوط (A) أفضل خواص ريولوجية وحسية. من هذه الدراسة أمكن الحصول على دقيق قمح ذات خواص جيدة بخلط عدة مسارات من طحن للقمح واستخدامه فى انتاج خبز قوالب ذات جودة مرتفعة .