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Research

Evaluation of Triticale and Wheat Grains for Cookie-Baking Characteristics.

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Abstract

This study was conducted to evaluate the cookie-baking potentials of Triticale and wheat grains cultivars and identifying the quality that will satisfy the various usage of baking by Americans families living in the southern states of USA. The major lines used consisted of six triticale lines grown in three locations of Huntsville, Tuskegee and Marion Junction and nine additional wheat lines grown in Huntsville, Alabama, USA. Cleaned grain seeds were tempered to moisture level of 11-13% under the ambient room temperature, and milled on a Brabender Quadramat Junior Mill (ACT, Ohio). Data were collected on yield of flour rate, middling and grain bran that were calculated and expressed as percentage of the total milled fraction. Data were further subjected to analysis of variance and the differences among the means were compared by Duncan Multiple Range Test.
Triticale AM 2149 had the highest amount of flour protein while AM 2873 had the lowest percentage of flour protein. Wheat flour of Coker 68-15 had the highest cookie diameter among the wheat and triticale lines. Triticale AM 2863 had the highest baking volume, while AM 2149 had the lowest baking volume. The cookie diameter of triticale grain flour was negatively correlated to flour protein and sedimentation values, while there was a positive correlation between cookie volume and flour ash among wheat lines. Farinograph, mixograph and alveograph data indicated that triticale flour was weak compared to wheat flour and was considered a desirable property of a good cookie baking flour. Wheat grain flour indicated a high baking strength that contributes to cookie volume than cookie spread. These results indicated that triticale flour can be used to prepare an acceptable cookie with desirable spread than cookie volume.

KEY WORDS: *Triticale grain, cookie diameter, cookie volume wheat grain, farinograph, alveograph, mixsogrpah, baking flour.*

Introduction

Majority of the world's population depend on cereal grains for the supply of about two-thirds or more of their protein intake. Unfortunately, cereal grain proteins are of poor quality compared to animal protein due to deficiency of certain essential amino acids. However, triticale with its good protein and amino acids properties seems to be a promising substitute in improving protein nutrition in the cereal consuming nations. Triticale is a generic hybrid between wheat and rye (Briggle, 1969). It possesses the chromosome complements of both parental species. The objective in making this crossing was to include the combining traits of grain quality and productivity of Triticum (wheat) with the vigor, hardiness and disease resistance quality of Secale (rye).

Several investigators have indicated that triticale grain generally contains a higher amount of protein along with better amino acids balance (Villegas et. al., 1970; Ahmed and McDonald, 1974; Knipfel, 1969), when compared to some wheat varieties. The protein efficiency ratio of triticale has been found to be equal to that of rye and higher than wheat (Knipfel, 1969). Triticale grain gained the attention as a good source of protein with relatively high lysine content (Villegas et. al,. 1970). Even though triticale exhibited a higher protein quality and quantity, the plant breeders were confronted with many inherent liabilities such as high sterility, low tilling capacity and shriveled endosperm in mature plant population.

Bread baking loaf quality of triticale flour is quite inferior to that of wheat flour. Triticale flour does not possess the gluten forming properties instead it has a low bread loaf volume and poor grain score (Tsen et. al., 1974). In addition there is high level of amylase activity responsible for water binding properties of the starch and high sulfhydryl compound contents are further responsible for the weak triticale dough properties.

Perhaps triticale flour could be found suitable for cookie making because of its weak dough properties. This study therefore was designed to achieve the following objectives:

1. To conduct a comparative study on cookie spreading properties of triticale and wheat flours.
2. To determine the relationship between certain rheological properties: absorption, mixing tolerance, dough stability and elasticity using fariongraph, mixograph and alveograph in predicting the cookie making properties.

Materials and Methods

The major lines of grain used in this study consisted of six triticale lines grown at three different locations of Alabama: Huntsville, Tuskegee and Marion Junction counties and nine wheat lines grown in Huntsville in 1976.

Preparation of samples

Cleaned seed samples of 1.5kg were tempered to a moisture level of 11-13% at the ambient temperature and then milled on a Brabender Quadrumat Junior Mill (ACT, Ohio model). The yield of flour, middling and bran were recovered, calculated and expressed as percentage of the total yield of all fractions.

Moisture, sedimentation value and flour ash were determined by the AACC method (1962). Protein contents of the flour were determined by the Kjeldahl procedure (N x 5.7) (AACC, 1962).

The flours were tested on a mixsograph at spring setting of 12 by the AACC mixsograph method of (1962). The percentage absorption used was that of farinograph minus 12. Area under the curve was calculated by cutting the copy of the chart, weighing it and using the following formula:

Area under the curve (cm2) = Weight of the paper (g) x 0.0147,
where 0.0147 was a correction factor obtained by running an experiment
to determine the accuracy of the method.

The correlation coefficient between the area obtained by this method for the Xerox paper on which copies of mixograph were made and the actual area measured was r2 = 0.9972 (n = 19) (Finney and Shogren, 1972). Farinograph study was conducted on each flour according to AACC farinograph procedure (1962) using a 300-gram mixer and enough water to centre the curve to the Brabender unit (BU) line. The term used to describe the farinograms were based on Fariongraph Handbook (Shuey, 1972). The alveograms were obtained according to the procedure of Chopin (1973) using constant absorption, 250g flour and 2.5% sodium chloride (NaCl) solution. Cookie was baked by straight dough procedure (AACC, 1962). The cookie formula consists of: 60% granulated sugar, 30% shortening, 1% sodium bicarbonate ($NaHCO_3$), 0.75% ammonium bicarbonate (NH_4HCO_3), 3% non-fat dry milk and 1% NaCl.

Baking Procedure

Sugar, shortening and sodium bicarbonate (baking soda) were creamed for three minutes in a 12 quart bowl of Hobert A-120T mixed for the second speed force. Sodium chloride was dissolved in 100ml of water and then milk was added, after which the contents were added to the creamed mixture during mixing at low speed for one minute. After mixing, the dough was removed from the bowl with hand and compressed as little as possible. Dough was sheeted, rolled and spread on trays and then cut with cookie cutter of 6cm in diameter (National Manufacturing Company, Nebraska, USA). Baking was carried out immediately for 10min, at 400oF (204oC) in a rotating type oven to ensure evenly baking temperature. The diameter of the baked cookies was measured using the alveograph plastic measurement. The thickness of the cookie was also measured with the alveograph plastic measurement. The cookie volumes were calculated using the formula of:

Πr2h, where Π constant is 3.142, r being the radius of the cookie

and t the thickness of the cookie (Finney et. al., 1949; Garnatz, et. al., 1943).

Statistical Analysis

Analysis of variance was used to test the data and the difference among the means were compared using Duncan multiple range test (Duncan, 1955). Also simple correlation coefficient was calculated in all possible combinations between the cookie quality characteristics and instrumental parameters (Duncan, 1955).

Results

The milling extraction rates of six triticale lines grown in Huntsville, Alabama are presented in Table 1. Location had a significant effect on the percentages of flour and middling yields. There was no significant effect of location on percentage of bran and flour ash. Triticale AM 3678 had a higher flour yield fraction and lower bran yield than other cultivars. Also, with an exception of Arthur 71 and Coker 68-15 wheat lines in Table 2, triticale AM 3678 had the highest flour yield and the lowest bran fraction. Compared to wheat lines the flour ash contents of triticale lines was generally higher. Triticale flour ash varied from 0.64 to 0.95, while that of the wheat ranged from 0.35 to 0.61. Triticale AM 2873and AM 3680 grown in Huntsville had higher flour ash content than others.

The milling extraction rates of wheat lines are presented in Table 2. Arthur 71 had significantly higher flour yield while Wakeland had a lower flour yield. The middling of the wheat grain lines varied from 2.5% to 10.5% Agent 2285 had significantly higher percentage of middling while Coker 68-15 had lower percentage yields of middling. Durum Cando had significantly higher percentage of flour ash while McNair 3069 and Wakeland had lower percentages of flour ash.

The cookie baking characteristics of triticale flours are presented in Table 3. There was no significant effect of location on the cookie baking parameters. The triticale lines differ significantly in flour protein, sedimentation value and cookie volume. Triticale AM 2149 had the highest flour protein content than other triticale grain flour.

The cookie baking characteristics of flours from nine wheat lines are presented in Tale 4. The flour protein contents varied from 9.3 to 11.9 percents. Agent 2285 had significantly higher percentage of flour protein while Blue Boy had lower percentage flour protein. The sedimentation value of wheat lines varied from 27.5 to 69.0 milliliter. Wakeland had significantly higher sedimentation value while Durum Rolette had the least sedimentation value. The cookie diameter of the wheat flours varied from 5.9 to6.8 centimeters. Coker 68-15 had the highest significant cookie diameter while Durum Cando had the least cookie diameter. The cookie volume from the wheat flours ranged from 16.4 to 33.9 cubic centimeters. Wakeland had significantly higher cookie volume while Durum Cando had the least cookie volume.

Simple correlation coefficients between cookie baking characteristics and various properties of triticale lines are presented in Table 5. The mixsograph flour weakening angle (MWA) had a positive and significantly correlated with the mixsograph flour drop-off time (MDO) suggesting that triticale flour possesses a feeble elasticity dough quality. The flour protein had a significantly positive correlation with the sedimentation value. The cookie diameter was negatively correlated with flour protein indicating that triticale flour protein with its bulky size depressed the spreading quality of triticale flour dough cookie. Also the cookie diameter was negatively correlated with the sedimentation value.

Simple correlation coefficient between cookie characteristics of wheat flours are presented in Table 6. Wheat flour had a significantly positive correlation with bran fractions. Also the cookie volume of wheat flour had a significantly positive correlation with the flour sedimentation value.

Simple correlation coefficient between triticale flour cookie characteristics and various parameters measured by farinograph, mixsograph and alveograph are presented in Table 7. Farinograph peak time had positive correlation with farinograph stability, mixograph peak time and alveograph height. Also farinograph stability had a negative correlation with mixograph tolerance index but had positive correlations with mixsograph peak time and alveograph height (ALH). Cookie diameter was positively correlated with mixsograph peak time (MPT), mixsograph drop-off (MDF) and mixsograph weakening angle (MWA) and alveograph height (ALH). Also alveograph G index had positive correlation with alveograph ratio of P/L.

Simple correlation coefficient between wheat flour cookie characteristics and various parameters measured by: farinograph, mixsograph and alveograph are presented in Table 8. Cookie volume was positively correlated with farinograph peak time (FPT) of flour dough development and farinograph stability (FST) but negatively correlated to mixsograph mean tolerance index (MTI). Farinograph stability had positive correlation with farinograph peak time (FPT) and mixsograph tolerance index (MTI) but negatively correlated with alveograph cookie height. Also mixsograph drop-off was positively correlated with alveograph work done (ALWD).

Discussions

The extraction rates of triticale grains grown in Huntsville, Alabama indicated a general improvement in the flour yielding capacity of these hybrid grains. With the exception of triticale AM 2863 the percentage flour and bran yields are comparable if not the same to some of the wheat grains such as Agent 2285, Coker 747, Blueboy, Wakeland and Durum Cando. This may perhaps be due to improvement in grain characteristics such as reduction in shriveling. Earlier studies have recorded lower flour yields (Anderson et. al., 1972; Lorenz et. al., 1974; Unrau and Jenkins, 1964). Triticale flour had considerable higher amounts of flour ash than wheat. Triticale flour ash contents varied from 0.74% to 0.955%, while wheat flour ash ranged from 0.355 to 0.53%. High flour ash indicates incomplete separation of bran and flour.

Simple correlation coefficients between cookie baking characteristics and various properties of the triticale flour dough indicated cookie diameter was significantly and negatively correlated with flour ash. Apparently, flour ash and flour protein had dense and bulky sizes that affected cookie diameter by depressing the triticale flour dough spreading quality. This fact had been further supported by earlier work of Badi et. al., (1976) with wheat flour which pointed out that inefficient separation of milling fractions affected cookie spread significantly resulting in a poor top grain character and dense compact cookies. Sedimentation value reflected flour protein quality and quantity for baking. Generally, triticale flour had relatively lower sedimentation values compared to wheat grain flours. Simple correlation coefficients between cookie characteristics and various properties of wheat flour dough indicated cookie volume was positively correlated with sedimentation value. This indicated that the baking strength of wheat flour due to dough (gluten) content contributed to the cookie volume than cookie diameter. Garnatz et. al., (1943) concluded on the basis of studies conducted on cookie baked from various streams of white winter wheat that as the spread factor diminished, the protein and ash, apparently the viscosity of the flour increase. This was true for the cookies baked from triticale flour. Simple correlation coefficient indicated cookie diameter was negatively correlated with flour protein and sedimentation value.

Mixsograph data indicated that triticale flour dough generally had higher mixsograph weakening angle and sharp drop-off compared to wheat. These characteristics indicated that triticale possesses a weak type of flour dough. Cookie diameter was positively correlated with weakening angle and drop-off. Consequently, a more desirable cookie with good top character can be prepared from a weak type of flour dough. The farinograph data on triticale and wheat flour dough reflected that triticale flour dough generally had lower stability, shorter peak time, shorter arrival time and shorter departure times when compared to that of wheat flour dough. This further indicated that triticale flour possesses a weak type of flour dough. The cookie volume of wheat flour dough was positively correlated with farinograph peak time and farinograph stability, but negatively correlated with farinograph mean tolerance index. These indicated the strong baking flour strength with longer dough development time, longer stability that contributed to baking volume rather than cookie spread.

Alveograph characteristics measure the ability of flour to stretch, expand and can determine the total effect of resistance to stretching and extensibility. The length of the curve represents the time required to burst the bubble which was inflated under constant water pressure. The work done or area under the curve represents the total effect of extensibility of the flour dough. The ratio P/L indicates resistance to stretching than extensibility. If the value of the ratio is higher than one when the flour dough is tested, this indicates higher resistance. Alveograph data in this study indicated that the wheat dough, with the exception of Durum Rolette, had higher ratio P/L, work done, extension index, length of the curve (L), resistant to extensibility compared to triticale flour dough. The cookie diameter of the triticale flour dough was positively correlated with alveograph height (ALH) suggesting that a good cookie baking flour does not necessarily need to have all the qualities of wheat dough as higher resistant to extensibility before an acceptable cookie can be prepared. Results clearly indicated that triticale flour can be used to prepare acceptable cookies.

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APPENDIX

Table1. Milling extraction rates* of triticale lines grown in Huntsville (1976)

Cultivars	% Flour	% Bran	% Middling	% Flour Ash
AM 2149	47.0a	45.0b	9.0a	0.83b
AM 2863	34.8b	60.9a	4.4c	0.63c
AM 2873	50.5a	41.2c	8.2b	0.82b
AM 3678	58.5a	37.2d	4.3c	0.80b
AM 3680	49.9a	44.9b	8.2b	0.64d
AM 3713	50.5a	41.4c	8.1b	0.95a

* Each value is the mean of three samples. Means not followed by the same letters are significantly different from each other by Duncan's Multiple Range procedure at 0.05 level of probability.

Table 2 Milling extraction rates* of wheat lines grown in Huntsville (1976)

Cultivars	% Flour	% Bran	% Middling	% Flour Ash
Agent 2285	50.5e	39.0e	10.5a	0.42c
Arthur 71	68.6a	27.2g	4.3c	0.36e
Blueboy	51.8d	45.1c	3.1d	0.39d
Coker 68-53	63.7b	33.9f	2.5f	0.40d
Coker 747	48.9f	46.4b	5.9b	0.40d
Durum Cando	47.8g	46.4b	5.9b	0.61a
McNair 3069	55.3c	41.5d	3.1d	0.35f
Wakeland	41.5h	55.7a	2.8e	0.35f

* Each value is the mean of three samples. Means not followed by the same letters are significantly different from each other by Duncan's Multiple Range procedure at 0.05 level of probability.

Table 3 Cookie baking parameters* of flours from Triticale lines grown in Huntsville (1976)

Cultivars	% Flour	% Bran	% Middling	% Flour Ash
AM 2149	10.2a	36.3a	6.1a	18.1c
AM 2863	9.0c	21.0b	6.2a	21.1b
AM 2873	8.6d	22.0b	6.1a	18.1c
AM 3678	9.5b	17.6c	6.2a	24.2a
AM 3680	8.4e	35.3a	6.2a	24.2a
AM 3713	9.1c	20.6b	6.3a	18.7c

* Each value is the mean of three samples. Means not followed by the same letters are significantly different from each other by Duncan's Multiple Range procedure at 0.05 level of probability.

Table 4 Cookie baking parameters* of flours from wheat lines grown in Huntsville (1976)

Cultivars	% Flour	% Bran	% Middling	% Flour Ash
Agent 2285	11.9a	53.0c	6.0e	19.8f
Arthur 71	9.8g	40.6g	6.8a	25.4d
Blueboy	9.3i	46.4e	6.3c	29.9b
Coker 68-15	10.7d	47.3d	6.9a	22.4g
Coker 747	9.5h	43.6f	6.6b	23.9e
Durum Cando	10.5c	30.5h	5.9f	16.4h
Durum Rolette	10.4f	59.9b	6.3c	25.7c
Wakeland	11.5b	69.0a	6.0e	33.9a

* Each value is the mean of three samples. Means not followed by the same letters are significantly different from each other by Duncan's Multiple Range procedure at 0.05 level of probability.

Table 5 Simple correlation coefficients between cookie characteristics, flour protein, flour ash, sedimentation values and the parameters as measured by mixsograph of triticale lines grown as a part of the Triticale Nursery in Huntsville (1977).

	MPT	MDO	MWA	Protein	Ash	Sedimentation	Diameter (cm)	Cookie Volume (cc)
MAB	0.0024	-0.0057	0.1547	0.0258	-0.2258	0.1665	-0.1346	-0.2881
MPT		-0.2329	-0.0885	-0.2752	0.1812	-0.1285	0.0506	-0.1832
MDO			0.6591**	0.1664	0.0536	-0.0822	0.0121	0.0085
MWA				0.2837	-0.0384	0.0571	-0.0447	0.0532
Flour Protein					-0.1764	0.4694*	-0.6319**	-0.1437
Flour Ash						0.0618	0.1193	0.1693
Sedimentation							-0.4571*	-0.1109
Cookie Diameter								-0.3434
Cookie Volume								

* Significant at 0.05 level of probability. ** Significant at 0.01 level of probability. Degrees associated with comparison = 17. MAB – Mixograph absorption; MPT – Mixograph Peak Time; MDO – Mixograph Drop-off; MWA – Mixograph Weakening Angle.

Table 6 Simple correlation coefficients between cookie characteristics, flour, bran middling, flour protein and sedimentation values of wheat lines grown in Huntsville (1977)

	Bran	Middling	Flour protein	Flour Ash	Sedimentation	Diameter (cm)	Volume (cc)	Baking Absorption
Flour	0.9551**	-0.2025	-0.3531	-0.2828	-0.2084	-0.7875	-0.3085	-0.4077
Bran		-0.4974	0.2243	0.1950	0.2493	-0.6774	0.4332	0.4344
Middling			0.3707	0.2812	-0.1404	-0.3377	-0.4064	-0.3197
Flour Protein				01121	0.2333	-0.4967	-0.0467	0.3437
Flour Ash					-0.7729	-0.5338	-0.6963	0.4146
Sedimentation						0.0473	0.8165*	-0.0491
Cookie Diameter							-0.003	-0.4738
Cookie Volume								-0.1351
Baking Absorption								

* Significant at 0.05 level of probability. ** Significant at 0.01 level of probability. Degrees of freedom associated with comparison = 7.

Table 7 Simple correlation coefficients between cookie characteristics and various parameters measured by farinograph, mixograph and alveograph of flours from triticale lines grown at three Alabama locations (1977).

	FPT	FST	MTI	MAB	MPT	MDO	MWA	ALH	ALI	ALWD	ALR	DIA	VOL
FAB	-0.202	0.0407	-0.1928	-0.2943	-0.0377	0.0377	0.0020	-0.0189	-0.0706	-0.1206	-0.0939	0.0939	0.3327
FPT		0.6747**	-0.2293	-0.1132	0.6008**	0.0034	0.1688	0.4851**	0.624	-0.2228	0.2047	0.2811	-0.1376
FST			-0.5159	0.0492	0.5834**	-0.1501	-0.0682	0.5621*	0.0814	0.0814	-0.0282	0.1594	0.0123
MTI				-0.0301	-0.0550	0.0954	0.1430	-0.2250	-0.2198	-0.1102	-0.2216	0.2825	0.1602
MAB					0.1803	0.0248	0.0776	0.0251	0.3769	0.3729	0.2503	-0.1046	-0.2568
MPT						0.3012	0.4476	0.3826	0.2256	-0.0151	0.3001	0.5498*	-0.1388
MDO							0.8607**	-0.3918	0.2579	-0.1857	0.1495	0.6872**	-0.1996
MWA								-0.1826	0.5310*	-0.0570	0.3975	0.7225**	-0.1204
ALH									0.3099	-0.0369	-0.0759	0.5315*	0.0592
ALI										-0.0355	0.6853**	0.2236	-0.4567
ALWD											-0.1146	0.0529	-0.2514
ALR												0.0965	-0.4151
Diameter													-0.0187
Volume													

* Significant at 0.05 level of probability. ** Significant at 0.01 level of probability. Degrees associated with comparison = 16. FAB – Barionograph absorption; FPT – Fariongraph peak times; FST – Farinograph stability; MTI – Farinograph mean tolerance index; MAB – Mixograph absorption; MTI – Mixograph peak time; MDO – Mixograph drop-off; MWA – Mixograph weakening angle; ALH – Alveograph height (H); ALI – Alveograph G index; ALWD – Alveograph work done (W). ALR – Alveograph ratio of P/L.

Table 8 Simple correlation coefficients between cookie characteristics and various parameters measured by farinograph, mixograph and alveograph of flours from triticale lines grown at three Alabama locations(1977)

	FPT	FST	MTI	MAB	MPT	MDO	MWA	ALH	ALI	ALWD	ALR	DIA	VOL
FAB	-0.1374	-0.4920	0.3864	0.3118	0.3813	0.0020	0.5244	0.1763	-0.0772	-0.2959	-0.3496	-0.6585	-0.0289
FPT		0.8131**	-0.6773*	-0.4344	0.3938	0.4984	-0.4238	-0.6400	-0.1227	0.3098	0.5896	0.0325	0.6686*
FST			0.9026**	-0.5891	0.3391	0.5508	-0.3794	-0.7364	-0.1406	0.4569*	0.5379	0.2101	0.7546*
MTI				0.4743	-0.3454	-0.4176	0.4492	0.2547	0.2062	-0.6652*	-0.4222	-0.4182	-0.7462*
MAB					-0.1802	-0.5445	0.2662	0.4485	0.0495	-0.2325	0.0083	-0.4738	-0.1354
MPT						0.5179	0.2462	-0.0796	0.4635	-0.1320	0.9838**	0.1736	0.2562
MDO							0.3842	-0.5654	0.2852	0.7604*	0.1689	-0.111	0.2312
MWA								0.0681	0.4717	-0.3965	-0.2027	-0.6295	-0.4295
ALH									0.1361	-0.0314	-0.2248	0.3043	-0.5299
ALI										-0.5987	0.3067	-0.1345	-0.4501
ALWD											0.0333	0.5580	0.5962
ALR												0.0061	0.3491
Diameter													-0.0030
Volume													

* Significant at 0.05 level of probability. ** Significant at 0.01 level of probability. Degrees associated with comparison = 7. FAB – Barionograph absorption; FPT – Fariongraph peak times; FST – Farinograph stability; MTI – Farinograph mean tolerance index; MAB – Mixograph absorption; MPT – Mixograph peak time; MDO – Mixograph drop-off; MWA – Mixograph weakening angle; ALH – Alveograph height (H); ALI – Alveograph G index; ALWD – Alveograph work done (W). ALR – Alveograph ratio of P/L.