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Morphological, Physicochemical and Technological Characteristics of Some Egyptian Barley Genotypes

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Abstract: The current study aimed to test six genotypes of barley in a randomized complete bloks design in split distribution with 3 replications during 2018/2019-2019/2020 seasons in Agricultural Research Center in Giza, each experiment included four promising lines (L1, L2, L3 and L4) and two cultivated varieties (Giza 2000 and Giza 136). The results showed that nitrogen had a main significant effect on all tested genotypes on all characters except spike length, similar effect of genotypes was significant on all characters except days from heading to physiological maturity. The interaction was significant for all characters except spike length and days from heading to physiological maturity. L1sems to be promising line, it gave highest value in spike length, number of grains per spike and grain yield under all fertilizer levels. Giza 136 and Giza 2000 cultivars were early in heading and Giza 136 cultivar plants were the tallest. Comparing the lines, L2 proved to be promising line in earliness and gave less number of maturity days and days from heading to physiological maturity while L3 reported the highest biological yield. Reducing fertilizer levels to 45, 30, 20 kg/N /fad have positive effect on all characters. The results of the physicochemical and technological study showed that the covered barley genotypes (Giza 2000, L3 and L4) gave a high percentage of hulls and hulled grains during a fixed period of time (15 min), also increased significantly in moisture content, ash, crude fiber and β-glucan compared with naked barley genotype (Giza 136, L1 and L2) during both seasons. Also, the data revealed that the naked barley genotypes (Giza 136, L1 and L2) recorded the highest rate of flour extraction and the lowest loss ratio after the milling process, In addition the total carbohydrate increased significantly during both seasons compared with covered barley genotypes (Giza 2000, L3 and L4). Covered barley Giza 2000 recorded the highest weight of 1000 grain, hectoliter and fat content, while recorded the lowest values in Ca, K, Na and Mg during both seasons. Meanwhile the variety Giza 136 was a higher in protein, iron content and lower in zinc content in both seasons. Regarding to pasta produced from genotypes of the covered barley, a significant increase in weight gain, swelling index and cooking loss was observed compared with pasta produced from naked barley and wheat semolina. In addition, the barley flour affected the color of pasta before and after cooking compared with the control sample (wheat semolina). Concerning to sensory evaluation of pasta product, there no significantly differences between all pasta products in aroma, taste. Also, the overall acceptability of all pasta was acceptable.

Key words: Covered and naked barley · Nitrogen fertilizer · Promising lines · Quality of barley genotypes · β-glucan · Pasta · Cooking loss and swelling index

INTRODUCTION

Barley (*Hordeum vulgare* L.) is the oldest cultivated and one of the first important cereal crops which grown in many environment. Also, it has a model experimental system because of its short life cycle and morphological, physiological and genetic characteristics. It has a large adaptation in many regions of the world, tolerates salinity,

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frost and heat, it is ranked fourth after wheat, corn and rice, it is the main crop in the northwestern coast, North Sinai and the newly reclaimed lands, it is mainly used to feed animals, brewing malts and human's food in some areas in Egypt. So there is a need to produce new high-yielding varieties of barley [1].

The total area under barley cultivation in Egypt oscillate according to the amount and distribution of annual rainfall. In the Nile Valley, the production area has decreased gradually especial at locations which can be grown with strategic crops such as wheat. The barley production area has increased, in the newly reclaimed lands. In Egypt barley was cultivated in 30436 hectare and total production of 100436 tons in 2019 season [2].

Environmental variables such as climate, soil and agronomic practices exert have a strong influence on different technological quality parameters of barley. This effect is marked in Mediterranean environments, where the climate characterized by increasing water deficit and thermal stress which may cause large fluctuations during grain filling, not only of grain yield, but also in grain quality traits, mainly protein content which is one of the most important traits in quality evaluation and breeding, is mainly influenced by climatic parameters and cultivar [3].

Barley is classified genetically varied cereal, as a barley spring and winter, two-row and six-row, hulled (covered barley) and hull-less (Naked barley). Hull-less barley is recognized for its nutritional quality [4] and it is a suitable cereal grain for use in many food products such as pasta and baked products. There are a large variation in the chemical composition between different barley types, where the hull-less barley contain less ash and dietary fiber and more starch, protein than covered barley, barley grain contains about 20% of dietary fiber [5, 6]. New varieties of barley have been produced to incorporate barley into food products, due to its health and nutritional benefits and functional ingredients [7]. Barley is now gaining renewed interests in several regions world, especially in Asia and Northern Africa, due to its nutritional value of its dietary fiber, lignins, non-digestible carbohydrates (β-glucan) content, phytochemicals and antioxidants such as tocopherols, flavonoids and phenolic acid [8]. Also, it is rich in K, Ca, Se, tryptophan, vitamins (A, B1, C and E) and polysaccharide, it has antidiabetic effect; regulates blood pressure; enhances immunity; protects liver; improves gastrointestinal function; anticancer, anti-inflammatory, antioxidant, hypolipidemic and the best raw material of modern diet to promoting weight loss [9]. β-glucan, an important dietary fiber in barley, varies between 3 and 7% [10], also significantly lowered blood cholesterol [11]. Moreover, barley β-glucan increases the viscosity of digestion in the intestine, slowing down the rate of starch digestion and absorption [12]. Foods made from whole barley increase satiety and weight loss, therefore, barley can be used as a partial or total substitute for wheat, rice and corn in a large number of food products [13].

Pasta is one of the most public staple food in many countries in the world. It is a cheap, easy to integrate with other foods and easy to cook. Also, it is rich in energy and poor in nutrient [14]. It has a relatively long shelf life when it is stored appropriately and it is the main product made from grains that is part of the daily diets of the most people in large number of countries. It is also a good source of carbohydrates and low in fat, but low in soluble dietary fiber. Traditionally pasta are made from wheat semolina, recently other cereals have been used to partially replace it [15]. There is a few of studies that document the changes to the physiochemical properties of food products that β-glucan inclusion, these changes have importance with regard to product palatability and consumer acceptance and must be studied for good palatability pasta [16]. The main objective of this study is to screening barley genotypes to investigate the changes in yield and yield component, some qualitative traits of level of nitrogen fertilizer and the performance, morphological, physiochemical and technological characteristics and study replacing barley flour at different ratio by wheat flour, as well as its effect on the quality of pasta manufacturing and nutritional quality to reduce the total dependence on wheat and reducing import of wheat

MATERIALS AND METHODS

Field Experiment: Field experiment were carried out at in Field Crops Research Institute, Barley Division at the Agricultural Research Center in Giza location in Egypt of two successive seasons (2018/2019 and 2019/2020) in three replications with a split plot by using 6 genotypes to study the performance, Morphological, physiochemical, technological traits and yield and it's components.

Plant Materials: The experimental materials for the present study consisted of six barley genotypes. These genotypes were four promising lines (L1, L2, L3 and L4) two cultivated varieties (Giza 2000 and Giza 136). Name, pedigree and source of these genotypes are in Table 1.

Table 1: Names, pedigree, seeds and row types of the six barley genotypes

No.	Name	Pedigree	Seed and Row type
1	L1	PETUNIA2/8/CONGONA/3/ATACO/ACHIRA//HIGO/7/ ZARZA/5/GLORIA-BAR/4/SOTOL//2762/BC-B/3/11012.2 /TERN-B//H272/6/SEN	Naked, 6 –rowed type
2	L2	STIPA/PETUNIA 1//KOLLA/BBSC/3/GIZA 124	Naked, 6 –rowed type
3	L3	ROBUST/TOCTE	Covered., 6 –rowed type
4	L4	CBSS01Y00090S-0Y-8M-0M-2M-0Y	Covered, 6 –rowed type
5	Giza 2000	Giza 121/Giza 124	Covered, 6 –rowed type
6	Giza 136	PLAISANT/7/CLN-B/4/S.P-B/LIGNEE640/3/S.P-B//GLORIA-BAR/COME-B/5/FALCON-BAR/6/LINO	Naked, 6 –rowed type

Experimental Design: A split plot design with randomized complete blocks arrangement was applied in this study using two factors. The main plots were nitrogen rate treatments, the sub plots were devoted to the barley genotypes

Nitrogen treatments (main plots)
Three nitrogen were applied at 1- 45 kg/N/fed.
2- 30 kg/N/fed.
3- 20 kg/N/fed.
Genotypes (sub-plots)

Seeding was done by hand with seeding rate of 50 kg seeds/Fadden in rows, 20 cm apart. Plot size area was 3.5 x 2 m = 7 m^2 and contains 10 rows of 3.5 m long each seeding date was on December 27 in both seasons. The other cultural practices were applied as recommended for barley at Middle Delta district.

Table 2: Chemical analyses of the water at the experimental site in (2019 and 2020) winter seasons

Analysis	Seasons 2018/2019	2019/ 2020
Chemical Analysis		
PH	7.9	7.7
EC	0.41	0.43
Soluble cation		
Na^+	1.70	1.69
K^+	0.35	0.37
Ca^{++}	1.25	1.24
Mg^{++}	0.93	0.92
Soluble anions		
HCo_3^-	1.30	1.29
Cl^-	1.85	1.82
So_4^{--}	0.95	0.92
SAR	1.63	1.61

Data Recorded:

- Days to heading (HD): was calculated according to the date of head appearance of 50% of plant plots.
- Days to Maturity (DM): was calculated as number of days from sowing to physiological maturity on plot basis.
- Grain filling period estimated in days as the difference between days to maturity and days to heading.
- Plant height in cm: estimated from soil surface to spike top without owns.
- Spike length in cm.
- Number of grains/spike (NG/S): Number of grains/spike as an average of 10 spikes.
- Grain yield (GY) in t/ha.
- Biological yield dry weight of grains plus straw yield per ha.

Physicochemical and Technological Studies

Pasta Materials: Wheat semolina flour and spices (salt, curry, onion, powder and coriander) were purchased from local market.

Methods

Physical Properties of Barley Grains: Barley were manually cleaned to remove foreign matter, broken and immature seeds. Then, seeds subjected to determine physical properties as follows:

Weight of 1000-grain: The weight of 1000-grain was measured on cleaned grain sample and was determined by weighing 100 grain in triplicate and then extrapolating this weight to 1000 grain .ISTA [17].

Hectoliter Weight: Hectoliter weight was determined by standard methods of AACC [18] and expressed in kilograms per hectoliter (Kg/h1)

Hulling Process of Barley: Barley varieties were hulled by using a small laboratory machine Homemade for 15 minutes to obtain three products: hulls, Unhulled grain and hulled grains.

unhulled grains % = [weight of unhulled grain (g)/ weigth of raw barley (g)]*100 hulled graind % = [weigth of hulled grain (g)/ weight of raw barley (g)]* 100

hulls % = [(weigth of raw barley (g) - [hulled grain (g) + unhulled grain (g)])/ weight of raw barley (g)] * 100

Milling Process of Barley Grains: Hulled barley grains were milling through a Buhler, MLU-202, the flour was sifted through sieve (450- 315 μ) to produce coarse flour (E1) and through sieve (250-90 μ) to produce fine flour (E2). The barley flour was stored in poly ethylene bags until uses.

Extraction % (E) = [weight E (g)/ hulled grains (g)] * 100

Losess % = [(weight of hulled grains (g) – [E1g + E2g]) / weight hulled grains (g)] * 100

Chemical Composition: Moisture, crude protein, crude fat, ash and crude fiber contents of barley flour (E2) were analyzed according to the procedures described in AOAC [19]. Total carbohydrate was calculated by difference.

***β*-glucan Gum:** *β*-Glucan was extracted from whole barley flour as described by Temelli [20] . The yield (w/w) of *β*-glucan gum was calculated by the weighing of gum obtained from 100 g of barley flour.

Elements Content: Macro elements (Ca, K, Na and Mg) and micro elements (Fe and Zn) for barley flour (E2) were determined by Perkin Elmer Atomic Absorption Spectrophotometer. (Model Agilent Technologies 4210 MP-AES) as described in AOAC [21].

Color Attributes: The color attributes of resultant barley flour (E2), pasta before and after cooking were determined according to the method outlined by McGurie [22] using a hand-held Chromameter (model CR-400, Konica Minolta, Japan). The results were expressed in terms of: L* (lightness), a* (redness-greenness) and b* (yellowness-blueness).

Preparation of Pasta: Barley flour extracted (E2) was used with wheat flour in the preparation of pasta and a preliminary experiment was made to identify the best percentage of addition from barley flour to wheat flour in terms of taste and general acceptance. The level of replacement of barley were 20, 30, 40, 50 and 60% and the best acceptable percentage was 50%. All samples of pasta were produced at 50 % of barley flour with 50 % wheat flour and control pasta sample was produced from wheat flour (100%), without barley flour addition. The spiced were onion powder, coriander, Curry and salt are shown in Table 3. Gelatinization of barley flour was made with a part of the added water, blend with wheat flour and spices, then added the rest of the water and dough was stirred for 15 min, the dough was placed into a plastic bag and conditioned for 30 min to ensure that moisture spread evenly. The mixture was manufactured as macaroni using an Imperia Trading S.r.I. 10098 RIVOLI (TO)-C.so Susa, 242. The fresh pasta was dried at room temperature for 35 min. then dried at 40°C overnight then packed into plastic bags and stored in the refrigerator at 4°C before analysis.

Cooking Quality of Pasta:

Weight Gain %: Weight gain was determined according to Lai [23]. 10 g pasta was cooked in 300 ml of distilled water and cooked at optimal cooking time, rinsed with distilled water and left to cool for 5 minutes at room temperature. The cooled cooked pasta were reweighed.

weight grain (%) = [(weight of cooked pasta (g) – weight of nucooked pasta (10 g)) / weight of uncooked pasta (10g)] * 100

Swelling Index (SI): The swelling index of cooked pasta was determined according to the procedure described by Cleary and Brennan [16]. A 10 g sample of pasta, cooked at optimal cooking time then weighed and dried at 105°C until a constant weight.

The swelling index was expressed as:

SI = (weight of cooked pasta (g) – weight of pasta after deyring) / weight of pasta after drying

Cooking Loss %: The cooking loss was determined according to Kosović *et al*. [14] by measuring the amount of solid substance lost to cooking water. 10g sample of pasta was placed into 200 ml of boiling water. Pasta samples were cooked at optimum cooking time, cooking water was collected in a pre-weighed dish and was placed in a hot air oven at 105°C overnight and reported as a percentage.

Cooking loss (%) = [weight of dry residue / weight of dry past (10 g)] * 100

Table 3: Formulation of pre-seasoned pasta

	Wheat semolina flour	Barley flour					
Ingredients (g)	Control	P1	P2	P3	P4	P5	P6
Wheat semolina flour	100	50	50	50	50	50	50
barley flour	-	50	50	50	50	50	50
Onion powder	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Curry	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Salt	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Coriander	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Water (ml)	45	65	65	65	65	65	65

Control: pasta prepared from 100% semolina flour, P1= pasta prepared from 50% semolina flour +50% L1 flour, P2= pasta prepared from 50% semolina flour +50% L2 flour, P3= pasta prepared from 50% semolina flour +50% L3 flour, P4 = pasta prepared from 50% semolina flour +50% L4 flour, P5 = pasta prepared from 50% semolina flour +50% Giza 2000 flour, P6 = pasta prepared from 50% semolina flour +50% Giza 136 flour

Optimum Cooking Time: The optimum cooking time necessary to gelatinize the starch, were determined by using method according to AOAC [24]. 10g of pasta were boiled in 200 mL of boiling tap water and Every 5 seconds of cooking the pasta is removed and pressed between clear two glass plates until the white core of pasta disappeared.

Sensory Evaluation: Pasta was evaluated for color, texture, aroma, taste, overall acceptability. The evaluation was carried out by ten panelists using point hedonic scales to estimate the acceptability 1 to 9 (where 1 = very much disliked, 9 = very much liked,) [25].

Statistical Analysis: Data collected were statistically analyzed using Costat program COHORT6 Package. Since the data in both seasons took similar trends, the combined analysis of the data was done. For means comparison Least Significant Difference (LSD) at 5% level was applied, while for Physicochemical and Technological studies each season, the obtained data were exposed to analysis of variance (ANOVA). Duncan is multiple range was used to compare between means values [26].

RESULTS AND DISCUSSION

Effect of Variety: Combined analysis in Table 4 showed significant differences among the studied six genotypes and cultivars for yield and its components. L4 was the later for heading days and maturity but Giza 2000 was early for heading and spike height .On the other hand, L2 was early maturing while Giza 136 was the tallest and least in number of grains/ spike. L1 gave the highest values in grain yield whereas the L4 gave the least values of grain yield and biological yield.

The Interaction:

Days to Heading (day): Mean values of heading date as affected by genotypes, N fertilization rates and their interactions in their combined analysis are presented in Table 5. Data presented clear that the genotypes had a significant effect on heading date in their combined analysis of N fertilizer rate. The earliestvalues were 88.0 and 88.3 days, recorded for genotype Giza 2000 and Giza 136 under fertilization with 20 kg/N. Whereas the latest date for heading was recorded by genotype L4 under 45 kg/N , where recorded 99.0 days. The variation between genotypes in this trait was due to the amount of genetic make-up under study. These results are in good agreement with those [27, 28, 29, 30, 31].

Days to Maturity (day): Mean values of maturity date as affected by genotypes, N fertilization rates and their interactions in their combined analysis are presented in Table (5). Data presented clear that the genotypes had a significant effect on maturity date in their combined analysis of N fertilizer rate. The results in Table 5. Indicated that the lowest no of days to maturity was found in the L1 and L2 in 20 kg/N in their means of combined analysis respectively (123.6 days) and the highest mean was (129.4 days) recorded for genotype L4 in 45 kg/N, 129.4 days, in their combined analysis. These results are in good agreement with those [27, 28, 29, 30, 31].

Grain Filling Period (Day): Mean values of grain filling period date as affected by genotypes, N fertilization rates and their interactions in their combined analysis are presented in Table 5. Cleared that the genotypes had a significant effect on grain filling period date in their combined analysis of N fertilizer rate. The earliestvalues were 30.4 days, recorded for genotype L4 in 45 kg/N in

Table 4: Pertinent mean squares (MS) due to various sources of variation of combined analysis across genotypes, seasons and locations

S.V	d.f	H.D	M.D	G.F.P	PL	SP	NG/S	GY	BY
Seasons (S)	1	n.s	*	n.s	*	n.s	n.s	**	*
Nitrogen (N)	2	*	*	**	*	n.s	n.s	**	**
S x N	2	*	n.s	*	n.s	n.s	n.s	**	*
Genotypes (G)	5	*	**	n.s	*	*	**	**	**
S x G	5	n.s	n.s	**	n.s	n.s	n.s	**	*
N x G	10	n.s	*	**	*	n.s	*	**	**
S x N x G	10	**	*	n.s	*	n.s	*	**	**

d.f = degree of freedom
H.D = Days from sowing to heading.
M.D = Days from sowing to physiological maturity
G.F.P = Days from heading to physiological maturity
SP =Spike length
PL = Plant height
NG/S =Number of grain per spike
GY= Grain yield
BY = Biological yield
*, **, ^{ns}indicate significant at 0.05 and 0.01 levels of probability and non-significant, respectively

their combined analysis. Whereas the latest date for grain filling period recorded for genotype Giza 136 in 30 kg/N, 37.9 days, in their combined analysis. The variation between genotypes in this trait was due to the amount of genetic make-up under study. These results are in good agreement with those [27, 28, 29, 30, 31].

Plant Height: Mean values of plant height date as affected by genotypes, N fertilization rates and their interactions in their combined analysis are presented in Table 5. The results showed that the effect of nitrogen rate and the interactions . The highest plant height was found (120.0 and 118.4 cm, respectively) Giza 136 and L4, in their combined analysis without significant in 30 kg/N. Among the lowest mean was 76.9 in L1 at 20 kg/N in their combined analysis in the present study that is in agreement with [32]. Nitrogen can increase wheat growth by affecting cell division as well as assisting in the absorption of nutrient elements by the plant; hence the increase in nitrogen can increase the shoot height of the wheat plant [33].

Spike Lengths: The results of the analysis of variance in Table 5 showed that the effect of nitrogen, genotypes and interaction of nitrogen rate and genotypes level on spike length. According to the results of the mean comparison, the highest spike length was observed in their combine in the application of nitrogen fertilizers at the recommended rates (11.5 and 11.3 cm, respectively) in L3 and L1 at 45 kg/N without significant in 30 kg/N and the lowest spike length was 8.4 cm in Giza 2000 at 20 kg/N. These results agreement with Sirjastava and Mehrotra [34] who observed that during the two years of the experiment the use of nitrogen fertilizer increased the spike length.

Number of Grain per Spike (NG/S): Mean values of number of grain per spike date as affected by genotypes, N fertilization rates and their interactions in their combined analysis are presented in Table 5. The results showed that the effect of nitrogen rate and the interactions. The highest number of grain per spike was found 56.40 and 54.60, respectively in L3 and L1, at 45 kg/N in their combined analysis without significant in 30 kg/N. Among the lowest mean was 37.19 and 37.57 in Giza 136 and L3 at 20 kg/N in their combined analysis in the present study that is in agreement with the results reported by Shanggan *et al*. [35] and Hastrop *et al*. [36], also showed that the number of grain per spike in deterioration conditions was significantly.

Grain Yield (GY): Data in Tables 5. Cleared that the all interactions among the studied two factors had significant effect on grain yield in their combine. Therefore, the highest value was found on L1 at 45 kg/N and 30 kg/N without significant to decrease the nitrogen rate (7.33, 7.12 t/h. Sequentially) . On the other hand, the least value was found on Giza 136 at 20 kg/N (4.12 t/h).

Results in Table 5. Showed that the decrease the fertilizer N application rate from 45 to 30 kg/N not significant for all genotypes. Similar results were also found by [37, 38, 39, 40, 41].

Biological Yield (BY): Data in Tables 5. Cleared that the all interactions among the studied two factors had significant effect on biological yield in their combine. Therefore, the highest value was found on L3 at 45 kg/N and 30 kg/N without significant to decrease the nitrogen rate (18.61, 17.96 t/h. Sequentially. On the other hand, the smallest value was found on Giza 136 at 20 kg/N(10.20 t/h).

Table 5: Mean performance of 6 genotypes, combined across seasons and Nitrogen levels

Genotypes	Fertilizer	HD	MD	GFP	PL	SP	NG/S	GY (t/h)	BY (t/h)
					Genotypes				
L1		92.80	126.10	33.30	102.00	10.43	50.56	6.64	14.12
L2		93.30	125.77	32.47	103.97	9.63	45.58	5.75	15.85
L3		94.03	126.67	32.63	109.17	10.53	46.16	5.42	16.92
L4		95.03	127.27	32.23	108.87	10.17	43.58	4.82	13.82
Giza 2000		91.77	126.43	34.67	108.90	9.00	42.89	5.53	14.31
Giza 136		91.80	126.87	35.07	112.57	9.90	42.00	4.68	14.46
					Interaction				
L1	45	96.4	127.6	31.2	115.0	11.3	54.60	7.33	15.52
	30	92.4	127.1	34.7	114.1	11.0	51.17	7.12	15.24
	20	89.6	123.6	34.0	76.9	9.0	45.90	5.47	11.61
2	45	95.1	128.3	33.2	111.6	10.5	48.60	6.81	17.23
	30	93.8	125.4	31.6	110.2	9.4	46.13	6.16	16.89
	20	91.0	123.6	32.6	90.1	9.0	42.00	4.21	13.42
3	45	95.7	128.3	32.6	116.0	11.5	56.40	6.19	18.61
	30	95.4	126.9	31.5	111.4	10.4	52.50	5.49	17.96
	20	91.0	124.8	33.8	100.1	9.7	37.57	4.57	14.20
4	45	99.0	129.4	30.4	118.4	10.8	46.83	5.11	15.32
	30	94.1	127.8	33.7	117.9	10.6	44.60	5.10	15.11
	20	92.0	124.6	32.6	90.3	9.1	39.30	4.26	11.02
Giza 2000	45	95.3	127.3	32.0	114.0	9.5	48.67	5.90	15.52
	30	92.0	126.9	34.9	114.0	9.1	40.10	5.74	15.42
	20	88.0	125.1	37.1	98.7	8.4	39.90	4.95	12.00
Giza 136	45	96.7	128.0	31.3	120.7	10.4	45.97	5.04	16.76
	30	90.4	128.3	37.9	117.0	10.3	42.84	4.87	16.41
	20	88.3	124.3	36.0	100.0	9.0	37.19	4.12	10.20
L.S.D.		6.12	5.94	n.s	2.54	n.s	7.03	1.73	1.93

H.D = Days from sowing to heading
M.D = Days from sowing to physiological maturity
G.F.P = Days from heading to physiological maturity
PL = Plant height
NG/S =Number of grain per spike
GY= Grain yield
BY = Biological yield
SP =Spike length

Results in Tables 5. Showed that the decrease the fertilizer N application rate from 45 to 30 kg/N not significant for all genotypes. Similar results were also found by [37, 38, 39, 40, 41].

The results in grain yield and biological yield are in agreement with [42] who reported that the effect of nitrogen fertilizer on phonological characteristics of the crop could be due to its effect of promoting vegetative growth and tiller boosting capacity. Its shortage influences the phonological process particularly the vegetative and generative phases [43]. The crop respond positively as N rate increased from 0 to 30 kg/N but negative as increased from 30 to 45 kg/N [44, 45] on wheat.

Physicochemical and Technological Studies

Hulling Process, 1000 Grain and Hectoliter Weight of Barley Grain Genotypes: Hulls, unhulled and hulled barley grains are presented in Table 6. The results showed that the naked barley genotypes (Giza 136, L1 and L2) gave the highest of hulled grains compared to the covered barley genotypes (Giza 2000, L3 and L4) in 2018/2019 (1st season) and 2019/2020 (2 nd season) during a fixed period of time (15 min). On other hand L2 genotype also gave the highest percentage of hulled grains (97.81%) in (1st season) compared to L1 and Giza 136, however there are no significantly differences between them during (2nd season). Also, covered barley genotype L4 gave the highest percentage of hulled grains (88.17 and 89.87 %) compared to the other covered barley Giza 2000 and L3 in both seasons respectively. These results similar with Ludwig *et al*. [46] who revealed that the hulled rate in hull-less barley (naked) was up to 95% and some covered barley were presented more than 85% yield in hulling process. Decrease rate of hulls in naked compared to covered barley may be due to many hull-less barley lose husk during harvest because of the hull is loosely attached and easily removed. The hull amount of barley grain weight can range between 7 to 25% depending upon type, growing environment and grain size [47].

Table 6: Hulling process, 1000 grain weight and hectoliter weight of barley grain genotypes during 2018/2019 and 2019/2020 seasons

Genotypes / verities	Hulls (%)		Unhulled grain (%)		Hulled grain (%)		Weight of 1000 grain (g)		Hectoliter Weight(Kg/h1)	
Seasons	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
L1	$2.10^{c}\pm0.17$	$2.24^{bc}\pm0.15$	$1.08^{d}\pm0.07$	$1.15^{c}\pm0.04$	$96.82^{b}\pm0.11$	$96.61^{a}\pm0.19$	$38.50^{d}\pm0.65$	$39.72^{d}\pm0.64$	$81.34^{b}\pm0.11$	$82.39^{b}\pm0.26$
L2	$1.44^{d}\pm0.12$	$1.46^{c}\pm0.05$	$0.75^{d}\pm0.29$	$0.84^{c}\pm0.22$	$97.81^{a}\pm0.19$	$97.70^{a}\pm0.17$	$44.26^{b}\pm0.73$	$46.22^{b}\pm0.31$	$81.98^{a}\pm0.30$	$82.05^{b}\pm0.15$
L3	$6.82^{a}\pm0.19$	$6.80^{a}\pm0.07$	$6.30^{ab}\pm0.26$	$6.42^{a}\pm0.20$	$86.88^{f}\pm0.19$	$86.78^{c}\pm0.27$	$36.29^{e}\pm0.19$	$37.06^{f}\pm0.53$	$79.31^{d}\pm0.03$	$79.37^{e}\pm0.03$
L4	$5.17^{b}\pm0.06$	$3.85^{b}\pm 2.30$	$6.66^{a}\pm0.21$	$6.28^{a}\pm0.17$	$88.17^{d}\pm0.16$	$89.87^{b}\pm 0.17$	$40.81^{c}\pm0.39$	$41.50^{c}\pm0.21$	$81.40^{b}\pm0.10$	$81.65^{c}\pm0.05$
Giza 2000	$6.66^{a}\pm 0.28$	$6.67^{a}\pm 0.07$	$5.83^{b}\pm0.76$	$6.13^{a}\pm0.35$	$87.51^{e}\pm0.5$	$87.20^{c}\pm 0.32$	$48.29^{a}\pm0.17$	$48.92^{a}\pm0.03$	$82.03^{a}\pm0.05$	$82.72^{a}\pm0.36$
Giza 136	$1.97^{c}\pm0.06$	$1.99^{c}\pm 0.03$	$1.78^{c}\pm0.24$	$1.80^{b}\pm0.15$	$96.25^{c}\pm0.22$	$96.21^{a}\pm0.13$	$38.56^{d}\pm0.09$	$38.92^{e}\pm0.16$	$79.91^{c}\pm0.10$	$80.11^{d}\pm0.07$

L1= naked barley genotype, L2= naked barley genotype, L3 = covered barley genotype, L4 = covered barley genotype, Giza 2000 = covered barley variety, Giza 136 = naked barley variety, 1st = 2018/2019, 2nd=2019/2020, Values are mean of three replicates ± SD, means with different letters are significantly different at $P \leq 0.05$.

Weight of 1000 grain is useful to get an initial idea of the percentage of flour resulting from milling of grains, while hectoliter weight indicated the fullness of the grains and evaluated the high or low percentage of flour expected when milling of the grains. Table 6. Exhibits the physical properties of six barley genotypes. Data revealed that 1000 grain weight ranged 36.29- 48.29 g in1st season and ranged 37.06 - 48.92 g in 2nd season, while hectoliter weight ranged 79.31- 82 .03 kg/hl in 1st season, while ranged 79.37 - 82.72 kg/hl in 2nd season, where Giza 2000 had the highest of 1000 grain weight (48.29 and 48. 92 g) and Hectoliter weight (82.03 and 82.72 kg/hl) during both seasons respectively. On other hand hectoliter weight was high in L2 genotype (81.98 kg/hl) and there were no significant difference between it and Giza 2000 in (1st season). Furthermore the L3 genotype had the lowest 1000 grain weight and hectoliter weight in both seasons. These results were close with those obtained by [47, 48, 49].

Moisture Content, Milling Processes and Color Attributes: The estimating of moisture immediately prior the milling process is an important economic factor as it affects the dry matter content (flour extraction rate). Table 7. Illustrated the moisture content of barley genotypes, where the moisture content ranged 11.11- 11.75% for covered barley genotypes, while ranged 10.38 - 10.86 % for naked barley genotypes during both seasons. On the other hand the results indicated that the covered barley genotype were higher in moisture content compared with naked barley genotype, these results agreed with [49, 50].

After the milling process of barley grains and sieving of whole flour, some fractions were resulting: coarse flour (E1) resulting from sieve 450 - 315µ and fine flour (E2) from sieve 250-90 µ are shown in Table 7. Milling process of the covered barley genotypes took 15 min. resulted fine flour (E2) ranged (72.88 -79.03 %), while the naked barley took 10 min. and recorded the highest fine flour (E2) ranged 83.32 - 85.36 % in both seasons. Also, the highest fine flour (E2) rate was observed 85.26 and 85.36 %for naked barley Giza 136 compared the other barley genotypes during both seasons as well as covered barley genotype L3 was recorded the highest fine flour (E2) rate 78.73 and 79.03 % compared the other covered barley genotypes during both seasons. Fine flour reduce in covered barley may be to high moisture content of barley grains before milling. In previous studies found that there are negative correlation between moisture content of barley grains before the milling and The amount of flour extracted , when the moisture increase, the husk and outer layers of grains become more moist, so that prevent the form of fine flour particles during milling, also found that the flour yield extraction was lower in covered (hulled) than in naked (hull-less) barley varieties when increase moisture content of grains before the milling [51]. In addition, the increase in the moisture content of the milled grain resulted in the yield increase of coarse flour [52].

Moreover, in the same Table 7. The data indicated that to lower loss ratio of naked barley during milling process than covered barley may be due to the naked barley requires less time in the milling process as a result to lower moisture content.

Color attributes of the flour resulting from sieve 250-90 µ are presented in Table 7. From this data it could be noticed that the genotypes of covered barley had the highest lightness L* compared with genotypes of naked barley during both seasons, also genotypes of covered barley recorded the highest yellowness-blueness values b* during 1st season, as well as naked barley Giza 136 during both seasons barley, while Giza 2000 recorded (-0.25 and -0.27) during both seasons. The color of covered barley flour was significantly improved (become brightness) may be due to increase the moisture content of barley grains before milling. These results agreed with Abdel -Gawad *et al*. [51] and Izydorczyk *et al*. [53] who stated that the increasing of the moisture content of barley before milling improved flour brightness with a moderate loss of flour yield.

Table 7: Moisture content, milling processes and color attributes during 2018/2019 and 2019/2020 seasons

				Milling process						Color attributes for the Extract flour from Sive (250-90 µ)					
Genotypes/verities	Moisture content (%)		Time (min)	Extracted flour (E1 %)		Extracted flour (E2 %)		Losses %		L*	a*	b*	L*	a*	b*
Seasons	1st season	2nd season	Both seasons	1nd season	2nd season	1st season	2nd season	1st season	2nd season	1st season			2nd season		
L1	10.85^{d} ±0.05	10.86^{d} ±0.15	10	8.88^{d} ±0.11	8.53^{d} ±0.03	83.32^{c} ±0.03	84.29^{c} ±0.31	7.74^{d} ±0.12	7.17^{d} ±0.25	93.15^{c} ±0.07	0.09^{e} ±0.005	7.14^{b} ±0.04	93.15^{e} ±0.01	0.10^{e} ±0.01	7.14^{c} ±0.01
L2	10.50^{e} ±0.10	10.80^{d} ±0.05	10	8.11^{e} ±0.04	8.13^{d} ±0.04	84.45^{b} ±0.05	84.82^{b} ±0.04	7.43^{d} ±0.07	7.05^{d} ±0.20	93.08^{c} ±0.29	0.13^{d} ±0.005	7.01^{b} ±0.15	93.01^{e} ±0.03	0.12^{d} ±0.02	7.04^{d} ±0.05
L3	11.26^{c} ±0.06	11.11^{c} ±0.13	15	11.74^{c} ±0.29	10.88^{c} ±0.05	78.73^{d} ±0.12	79.03^{d} ±0.15	9.52^{b} ±0.30	10.08^{b} ±0.16	94.85^{b} ±0.31	0.24^{c} ±0.015	7.52^{a} ±0.10	94.88^{c} ±0.14	0.22^{c} ±0.01	7.48^{b} ±0.02
L4	11.55^{b} ±0.05	11.45^{b} ±0.05	15	13.32^{b} ±0.32	12.22^{b} ±0.02	75.89^{e} ±0.45	76.67^{e} ±0.11	10.77^{a} ±0.44	11.10^{a} ±0.10	95.80^{a} ±0.84	0.28^{b} ±0.01	7.60^{a} ±0.06	96.02^{a} ±0.16	0.28^{b} ±0.01	7.62^{a} ±0.03
Giza 2000	11.75^{a} ±0.05	11.65^{a} ±0.05	15	16.04^{a} ±0.06	16.54^{a} ±0.54	72.88^{f} ±0.20	73.16^{f} ±177	11.07^{a} ±0.24	10.30^{b} ±0.49	95.32^{ab} ±0.52	-0.25^{f} ±0.01	7.51^{a} ±0.09	95.48^{b} ±0.05	-0.27^{f} ±0.02	7.52^{b} ±0.06
Giza 136	10.38^{d} ±0.06	10.62^{e} ±0.10	10	6.12^{f} ±0.03	6.24^{e} ±0.04	85.26^{a} ±0.05	85.36^{a} ±0.03	8.62^{c} ±0.08	8.40^{c} ±0.06	93.60^{c} ±0.22	0.33^{a} ±0.02	7.63^{a} ±0.13	93.63^{d} ±0.10	0.33^{a} ±0.01	7.65^{a} ±0.07

L1= naked barley genotype, L2= naked barley genotype, L3 = covered barley genotype, L4 = covered barley genotype, Giza 2000 = covered barley variety , Giza 136 = naked barley variety, 1st = 2018/2019, 2nd =2019/2020, Values are mean of three replicates ± SD, means with different letters are significantly different at $P \leq 0.05$

Table 8: Chemical composition and β-glucan content of barley flour resultant from sieve (250 - 90 µ) during 2018/2019 and 2019/2020 seasons

Genotypes/ verities	Ash		Crude fibber		Crude Protein		Crude Fat		Total carbohydrate		β-glucan % (w/w)	
Seasons	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
L1	1.11^{b}±0.01	1.13^{d}±0.02	0.61^{d}±0.04	0.63^{f}±0.10	9.20^{d}±0.01	9.56^{c}±0.07	0.71^{f}±0.02	1.06^{f}± 0.07	88.37^{a}±0.06	87.62^{a}±0.12	4.61^{d}±0.04	4.58^{d}±0.01
L2	1.19^{b}±0.09	1.17^{cd}±0.03	0.87^{c}±0.03	0.97^{d}±0.06	9.04^{e}±0.02	9.22^{d}±0.13	1.47^{c}±0.03	1.47^{c}±0.02	87.43^{b}±0.08	87.17^{b}±0.05	4.31^{f}±0.03	4.32^{e}±0.02
L3	1.53^{a}±0.02	1.61^{a}±0.03	1.23^{a}±0.04	1.24^{b}±0.04	9.57^{b}±0.07	9.67^{b}±0.03	1.35^{d}±0.02	1.38^{d}±0.02	86.32^{c}±0.11	86.10^{d}±0.04	5.41^{c}±0.03	5.53^{c}±0.02
L4	1.53^{a}±0.03	1.44^{b}±0.02	1.08^{b}±0.10	1.10^{c}±0.03	9.19^{d}±0.05	9.52^{c}±0.02	1.90^{b}±0.04	1.90^{b}±0.01	86.31^{c}±0.14	86.04^{d}±0.02	6.41^{a}±0.03	6.57^{a}± 0.02
Giza 2000	1.52^{a}±0.03	1.62^{a}±0.03	1.30^{a}±0.08	1.32^{a}±0.02	9.33^{c}±0.04	9.73^{b}±0.03	2.59^{a}±0.01	2.61.^{a}±0.01	85.26^{d}±0.03	84.72^{e}±0.02	6.09^{b}±0.14	6.25^{b}±0.03
Giza 136	1.10^{b}±0.10	1.21^{c}±0.01	0.63^{d}±0.10	0.70^{e}±0.01	9.69^{a}±0.03	9.93^{a}±0.07	1.08^{e}±0.03	1.20^{e}±0.03	87.50^{b}±0.16	86.96^{c}±0.07	4.48^{e}±0.01	4.54^{d}±0.04

L1= naked barley genotype, L2= naked barley genotype, L3 = covered barley genotype, L4 = covered barley genotype, Giza 2000 = covered barley variety, Giza 136 = naked barley variety, 1st = 2018/2019, 2nd =2019/2020, Values are mean of three replicates ± SD, means with different letters are significantly different at $P \leq 0.05$.

Chemical Composition and β-Glucan Content of Barley Flour: The chemical composition as ash, crude fat, crude protein, crude fiber and total carbohydrate of flour obtained from sieve (250- 90 µ) are reported in Table 8. From the data it could be noticed that covered barley flour of genotypes (L3, L4 and Giza 2000) significantly increased in Ash content and crude fiber content during both seasons compared with naked barley flour genotypes (L1, L2 and Giza 136 variety). Moreover data indicated that Giza 136 variety had the highest of crude protein content (9.69 and 9.93 %) followed by covered barley genotype L3 (9.57 and 9.67 %) in both seasons respectively as well as Giza 2000 variety (9.73 %) in (2nd season). Also the crude fat was higher in Giza 2000 variety (2.59 and 2.61 %) in both seasons respectively. while Total carbohydrate significantly increased in naked barley flour genotypes during both seasons. Similar results were recorded that Giza 136 had high content of protein and low content fiber and ash, while Giza 2000 had low content of protein and high content of fiber and ash [50]. Also, barley flour had 1.30% ash, 2.54 % crude fiber and 85.18% total carbohydrates [54], the crude protein content ranged 8.75 -11.77% as well as total carbohydrate ranged 78.49 - 81.86% respectively for hulled and hull-less barley flour [55], fat ranged 1.62-1.92% in hulled barley [56] . In the same Table 8. The data showed that β-glucan ranged 4.31 - 6.57 % w/w where, the highest content was found in covered barley genotypes compared with naked barley genotype during both seasons. A previous study reported that β-glucan contents ranged 4.55-6.08 % in barley genotype [57, 58, 59].

Minerals of Barley Flour: Minerals content of the barley flours was evaluated and presented in Table 9. Results indicated that the flour of naked barley genotype L1 significantly increased in K and Zn, also the covered barley genotype L3 was high in Ca, Na and Mg in both seasons. On the other hand the data observed that the covered barley Giza 2000 had the lowest Ca, K, Na and Mg, while the naked barley Giza 136 characterized with highest value Fe (5.59 and 5.60 mg / 100 g) as well as the lowest content in Zn (2.13 and 2.23 mg/ 100g) in both seasons respectively. Such findings are closes to those obtained with [49, 54, 58, 60].

Cooking Quality of Pasta: Cooking quality as weight gain, swelling index, cooking loss and optimum cooking time are presented in Table 10. Which showed that the cooking quality of pasta produced from wheat semolina

Table 9: Minerals of barley flour resultant from sieve (250 - 90 µ) during 2018/2019 and 2019/2020 seasons

	Macro elements mg/100g						Micro elements mg/100g					
Samples	Ca		K		Na		Mg		Fe		Zn	
Seasons	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
L1	49.95^{e}±0.6	50.17^{e}±0.05	143.50^{a}±0.09	143.03^{a}±0.03	41.07^{d}±0.08	40.03^{d}± 0.07	49.02^{c}±0.03	49.49^{c}±0.02	4.27^{c}±0.04	4.33^{c}±0.02	4.82^{a}±0.02	4.86^{a}±0.01
L2	68.87^{c}±0.19	68.96^{c}±0.06	128.79^{d}±0.21	128.87^{d}±0.10	41.59^{c}±0.09	40.83^{c}± 0.04	46.80^{d}±0.03	46.89^{d}±0.01	2.97^{e}±0.03	2.09^{f}±0.04	4.62^{b}±0.01	4.72^{b}±0.04
L3	85.22^{a}±0.24	85.58^{a}±0.02	136.43^{b}±0.12	135.75^{b}±0.02	60.91^{a}±0.11	61.02^{a}±0.11	57.08^{a}±0.09	56.89^{a}±0.11	5.01^{b}±0.02	5.07^{b}±0.02	2.43^{d}±0.02	4.47^{d}±0.02
L4	66.69^{d}±0.01	66.67^{d}±0.01	121.93^{e}±0.13	120.44^{e}±0.07	36.48^{e}±0.03	36.21^{e}±0.02	45.72^{e}±0.03	45.64^{e}±0.02	2.55^{f}±0.02	2.53^{e}±0.03	4.62^{b}±0.02	4.66^{c}±0.01
Giza 2000	44.08^{f}±0.16	44.10^{f}±0.09	114.01^{f}±0.11	113.94^{f}±0.06	31.57^{f}±0.02	31.80^{f}±0.01	40.47^{f}±0.02	40.09^{f}±0.13	3.62^{d}±0.03	3.60^{d}±0.01	4.37^{c}±0.02	4.40^{e}±0.01
Giza 136	74.89^{b}±0.12	74.91^{b}±0.03	133.56^{c}±0.05	132.93^{c}±0.07	46.11^{b}±0.20	45.96^{b}±0.06	53.36^{b}±0.03	53.01^{b}±0.01	5.59^{a}±0.01	5.60^{a}±0.01	2.13^{e}±0.01	2.23^{f}±0.02

L1= naked barley genotype, L2= naked barley genotype, L3 = covered barley genotype, L4 = covered barley genotype, Giza 2000 = covered barley variety, Giza 136 = naked barley variety, 1st season = 2018/2019, 2nd season =2019/2020, Values are mean of three replicates ± SD, means with different letters are significantly different at P $\leq$ 0.05.

Table 10: Cooking quality of pasta product prepared from wheat flour and barley flour cultivated at 2nd season

Samples	Weight gain (g)	Swelling index (SI)	Cooking loss (%)	Optimum cooking time (min.)
Seasons		2nd season		
Control	84.08^{f}±0.39	0.99^{d}± 0.06	4.66^{c}±0.18	9
P1	102.18^{e}± 0.61	1.24^{c}± 0.01	6.23^{b}± 0.11	10
P2	103.33^{d}±0.13	1.25^{c}± 0.02	6.13^{b}± 0.15	10
P3	116.78^{a}±0.26	1.42 ^{ab}± 0.15	6.57^{a}± 0.08	10
P4	113.37^{b}± 0.52	1.38^{b}± 0.02	6.61^{a}± 0.07	10
P5	117.33^{a}±0.43	1.45^{a}± 0.01	6.61^{a}± 0.05	10
P6	109.26^{c} ±0.44	1.25^{c}± 0.13	6.08^{b}± 0.03	10

Control : pasta prepared from 100% semolina flour, P1= pasta prepared from 50% semolina flour +50% L1 flour, P2= pasta prepared from 50% semolina flour +50% L2 flour, P3= pasta prepared from 50% semolina flour +50% L3 flour, P4 = pasta prepared from 50% semolina flour +50% L4 flour, P5 = pasta prepared from 50% semolina flour +50% Giza 2000 flour, P6 = pasta prepared from 50% semolina flour +50% Giza 136 flour, Values are mean of three replicates ± SD, means with different letters are significantly different at P $\leq$ 0.05.2nd season= 2019/2020

flour and some of barley genotypes flour. The data revealed that all the pasta samples supplemented with barley flour recorded the highest weight gain, swelling index, cooking loss and optimum cooking time compared to control pasta (wheat semolina). On the other hand the pasta produced from covered barley genotypes (P3, P4 and P5) increased significantly in weight gain, swelling index and cooking loss compared to the pasta produced from naked barley genotypes samples (P1, P2 and P6). Increasing of weight gain, swelling index, cooking loss in pasta produced from barley may be due to its higher in fiber and β-glucan [8], also due to the absorption of more water as a result of the presence of dietary fiber and β-glucan [61, 62]. The swelling index increased by replacement of wheat semolina with barley flour which contained of β-glucan [63, 14]. From these results, it was noted that despite the high of cooking loss of pasta produced from covered and naked barley flour compared with control, but it is still within the permissible limits. when the cooking loss less than 7% the pasta is acceptable and good quality [64]. The cooking loss may be caused after addition of barley flour as a results to formation of a weaker and discontinuous protein network , which reduces its ability to hold dry matter and leached the starch in the cooking water [65], also may be due to low drying temperature used in the production of pasta samples which does not allow the gluten network to associate with the β- glucans to form a strong structure that generally improves the quality of cooking pasta [63]. The difference in the cooking time might be attributed to their compositional differences [66].

Color Attributes of Pasta Samples Before and after Cooking: Color attributes of pasta samples before and after cooking are shown in Table 11. Our results showed that the barley flour affected the color of pasta before and after cooking. Pasta supplemented with barley flour had significantly decreased in brightness ($L*$) and yellowness-blueness values ($b*$) compared with the control wheat semolina pasta, which recorded the highest brightness ($L*$) value (75.70 and 61.01) and b* value (22.97 and 12.39) before and after cooking respectively.

Redness (a*) values significantly increased when addition of barley flour compared with control pasta (1.08 and 0.18) before and after cooking respectively. In addition, all pasta samples significantly decreased in color attributes after cooking. These results are in range with work by [14, 57].

Table 11: Color attributes of pasta samples before and after cooking in 2nd season

Samples	Color attributes before cooking			Color attributes after cooking		
	2nd season			2nd season		
Seasons	L^*	a *	b *	L^*	a *	b *
Control	75.70^a±0.60	1.08^d±0.08	22.97^a±0.41	61.01^a±0.66	0.18^d±0.01	12.39^a±0.14
P1	65.56^e±0.45	1.66^a±0.15	16.06^e±0.11	55.81^{d}0.31	1.46^a±0.12	9.92^e±0.08
P2	67.14^d±0.15	1.26^d±0.17	16.12^e±0.13	55.08^e±0.13	1.55^a±0.10	10.15^e±0.14
P3	69.06^b±0.55	1.48^b±0.10	16.80^d±0.06	56.01^d±0.15	1.23^b±0.05	10.57^d±0.15
P4	69.16^b±0.10	1.34^c±0.03	19.16^b±0.09	58.13^b±0.27	1.04^c±0.06	12.04^b±0.21
P5	67.94^c±0.44	1.20^d±0.03	17.08^c±0.07	56.70^c±0.33	1.07^c±0.11	11.63^c±0.06
P6	67.57^{cd}±0.40	1.40^c±0.04	14.49^f±0.19	54.78^e±0.27	1.41^a±0.11	9.03^f±0.12

Control: pasta prepared from 100% semolina flour, P1= pasta prepared from 50% semolina flour +50% L1 flour, P2= pasta prepared from 50% semolina flour +50% L2 flour, P3= pasta prepared from 50% semolina flour +50% L3 flour , P4 = pasta prepared from 50% semolina flour +50% L4 flour, P5 = pasta prepared from 50% semolina flour +50% Giza 2000 flour, P6 = pasta prepared from 50% semolina flour +50% Giza 136 flour, Values are mean of three replicates ± SD, means with different letters are significantly different at $P \leq 0.05$. 2nd season= 2019/2020

Table 12: Sensory evaluation of pasta product prepared from wheat flour and barley flour cultivated at 2nd season

Samples	Color	Texture	Aroma	Taste	Over all acceptability
Seasons			2nd season		
Control	7.85^a±1.10	8.40^a±0.69	8.50^a±0.84	8.20^a±1.03	8.35^a±0.62
P1	6.80^{ab}±1.10	7.75^{ab}±1.08	7.85^a±1.15	7.80^a±1.20	7.90^{ab}±0.90
P2	6.55^b±0.89	7.40^b±0.80	7.85^a±1.22	7.55^a±0.76	7.55^b±0.79
P3	6.90^{ab}±1.07	7.50^{ab}±0.88	7.65^a±1.01	7.75^a±1.01	7.75^{ab}±0.79
P4	6.80^{ab}±1.33	8.0^{ab}±0.91	8.30^a±0.82	7.90^a±0.96	7.85^{ab}±0.85
P5	6.75^b±1.08	7.15^b±0.94	7.50^a±1.26	7.30^a±0.94	7.20^b±0.85
P6	6.90^{ab}±0.90	7.90^{ab}±1.07	8.05^a±0.95	7.75^a±0.71	7.75^{ab}±0.92

Control: pasta prepared from 100% semolina flour, P1= pasta prepared from 50% semolina flour +50% L1 flour, P2= pasta prepared from 50% semolina flour +50% L2 flour, P3= pasta prepared from 50% semolina flour +50% L3 flour , P4 = pasta prepared from 50% semolina flour +50% L4 flour, P5 = pasta prepared from 50% semolina flour +50% Giza 2000 flour, P6 = pasta prepared from 50% semolina flour +50% Giza 136 flour, Values are mean of ten replicates ± SD, means with different letters are significantly different at $P \leq 0.05$. 2nd season= 2019/2020

Sensory Evaluation of Pasta Product Prepared from Wheat Flour and Barley Flour: The sensory evaluation of pasta product are shown in Table 12. The data revealed that there no significantly differences between all pasta products in aroma and taste. Also the data recorded that there are significant differences when substituted semolina with barley flour in color, texture and over acceptability. A highly significant decrease in color, texture and over acceptability was found in pasta P2 (6.55, 7.40 and 7.55, respectively) and P5 (6.75, 7.15 and 7.20, respectively) compared with control pasta sample, which recorded the highest color (7.85), texture (8.40), overall acceptability (8.35) and there were slightly differences between it and pasta P1, P3, P4 and P6 prepared from barley flour. The overall acceptability of all pasta samples were acceptable and the lowest were for P2 and P5. The production of pasta by substituting 50% of wheat semolina with barley flour was darker than that produced from durum wheat pasta [57, 67].

CONCLUSION

The obtained results show that there are some high yielding lines of barley which respond to lower doses of N and could be used as partial substitute to wheat, It could be concluded from this study the possibility of replacing barley flour at 50 % with wheat semolina flour to prepare pasta to reduce the total dependence on wheat crop and reducing wheat import.

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