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EFFECT OF GERMINATION PROCESS ON THE CHEMICAL AND BIOLOGICAL ACTIVE COMPOUNDS OF BARLEY AND OAT GRAINS

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ABSTRACT

In recent years, cereals especially barley and oat grains have attracted researches and commercial attention mainly due to their high contents of dietary fibers, β- glucan and phenolic compounds with high antioxidant activates. Therefore, a preliminary study was carried out to estimate the components of raw barley and oat grains as well as, the effect of germination process on chemical composition and biological active compounds. The obtained results reveled that the germination process had a great role on the efficiency of chemical composition of selected cereal grains. A large number of negatively valued components in the grains such as crude fibers and starch contents of barley and oat decreased with prolonging the germination time process and the reduction of their contents due to the activity of α–amylase enzymes during germination process which led to an increase in total sugars. Phytic acid decline with germination time increase.

Otherwise, protein contents gradually increased with prolonging the germination period being 15.24 and 12.96% after three days for barley and four days for oat, respectively. Prolonging the germination time increased the minerals content of barley and oat grains and improved the bioavailability of essential minerals. Moreover, β –glucan contents declined with increasing the germination time process.

Prolonging germination period increased total phenolic compounds, flavonoids contents and antioxidant activity, Catechin and pyrogallol were the major free phenolic compounds that existed in raw and germinated barley and oat grains. Nicotinic acid and Vit. B1 were the most abundant B complex vitamins in raw barley and oat grains and they highly increased during the germination period more than two folds recording 120.81 and 145.56 mg/100g & 335.21 and 441.62 mg/100g, respectively.

Finally, it could be concluded that germination process had positive effects to improve the bioactive compounds contents as total phenolic and flavonoids compounds, antioxidant activity and an increase in bioavailability of essential minerals and a higher content of Vit. B complex of barley and oat grains.

INTRODUCTION

Cereals are considered as one of the most important economic and food commodities in the world. Barley (*Hordeum vulgare* L.) is a major cereal grain, as a member of the grass family. Also, barley is a major crop for malting, brewing and for food production industries in the developed countries and it is utilized as fodder crop in the less developed and developing countries. Barley is a typical cereal grains composed primarily of starch, protein, fibers, lipids and minerals (Akar *et al.,* 2004).

The common oat (*Avena sativa*) is one of the species of cereal grain grown for its seed, being known to provide healthy human with nutrients. Oats have been grown since thousands of years, mainly as an animal feed

crop, but during the 19th century oats won acceptance as part of the human diets (Webster, 1986). At that time oats were generally consumed as oatmeal, but today oats can be found in various food products, as breakfast cereals, beverages, bread and infant foods (Johansson *et al*., 2007).

The barley accounts for 12% of the world's total cereal production and occupies the fourth position with respect to grain production after wheat, rice and corn, whereas, oats are the fifth largest cereal crop in the world (Jadhav *et al.,* 1998).

In Egypt, the average total annual area cultivated with barley grains are 87752 hectar which produced annually, 117113 tons (FAO, 2010).

Barley grain is an excellent source of soluble and insoluble dietary fibers and other bioactive constituents, such as vitamin E (including toco-tri-enols), minerals, and phenolic compounds (Qureshi *et al.*, 1986 and 1991). Oats are also a good source of various bioactive compounds, as antioxidants such as vitamin E, phytic acid and phenolic compounds (Peterson, 2001). Barley and oat are gaining renewed interest as a functional food ingredient due to the fact that barley and oat grains are a rich source of β- glucans, which represented 3-11% in barley and 3-7% in oats and its percentage varies with cultivar and environmental effects (Soares *et al*., 2007). HÜbner *et al*. (2010) showed that ß-glucan content in barley and oat was 3.8 and 4.2%, respectively.

The total phenolic content of barley varieties ranged from 0.881 to 1.457 mg/g as gallic acid. Also, the total flavonoids content of barley grains ranged from 0.325 to 0.527 mg/g and antioxidant activity of barley was 21.00 µg /g. (Holtekjolen *et al*., 2006 and Ragaee *et al*., 2006).

Germination process is a natural process occurring during growth period of seeds in which they meet the minimum conditions for growth and development (Sangronis *et al.,* 2006). Germination process has long been used as a way to modify taste, appearance and technological properties of grains (Belitz *et al.,* 2001) As well as, it causes breakdown in some components in barley and oat especially in ß- glucan contents which decreased during germination process to 2.98 % (Al-Rdaddi, 2008) due to the activity of ß- gluconase enzymes. Starch contents decreased due to the activity of α-amylase enzymes. As well as, protein contents of steeped oats also increased (Tian *et al*., 2010). Phytic acid content of germinated barley and oats after 96 hrs. decreased to 0.441% and 0.588 %, respectively HÜbner *et al.* (2010).

Germination process significantly led to increasment the total phenolic content and antioxidant activity of barley. Moreover, the antioxidant activity increased with in 12 hrs. of germination process after 12 hrs. (Sharma and Singh Gujral, 2010).

Therefore, this work was a trial to utilize of barley and oat grains which represent plentiful amounts as main sources of dietary fibers mainly, ß-glucan and other nutrients and to study the effect of soaking and germination processes on the chemical and nutritional properties of barley and oat grains.

MATERIALS AND METHODS

Materials

Barley grains (***Hordeum rulgare L***.), six rowed barley, Giza 132 were obtained from Barley Research Dept. Crop Res. Inst., ARC, Giza, Egypt.

Oat (***Avena sativa***) grains were obtained from Food and Feed Res. Inst., ARC, Giza, Egypt.

Methods

Preparation of raw materials

Malt was prepared from barley and oat grains as follows:

Dry grains were washed and soaked in tap water (1: 2 w/v) at room Temp. (25±5°C) for 8hrs. The grains were spread on wet surface at 25 ^{o}C for 2:3 days for barley and 3: 4 days for oat until they had germinated. During the germination period, the grains were sprayed and then dried at 55°C for 8hrs. to prevent the germination development. The dried barley and oat sprouts were milled using a Moulinex mill machine to a particles size less than 80 mesh.

Analytical Methods

Gross chemical composition

- Moisture, ash, protein, fat and crude fibers contents were determined according to the methods described in the A.O.A.C. (2007).
- Minerals content were determined after dry ashing according to the method described in the A.O.A.C. (2007), using atomic absorption amanitas (Perkin – Elmer, Model 3300, USA).

-Total sugars were extracted from the samples by water and clarified by lead acetate. Sodium oxalate was used to precipitate the excess of lead acetate. Total and reducing sugars were determined in the clarified solution by Somogy (1952) and Nelson (1974).

-Starch was determined according to the method described in the A.O.A.C. (2007).

- Phytic acid was determined according to the method described by Mohamed *et al*. (1986)
- Dietary fibers fractions were determined using Tecator fibretic system according to the method described by Van Soest and Bretson (1979).
- β –glucan was determined according to the method described by Carr *et al.* (1990).
- The total phenolic compounds were determined with Folin - Ciocalteu reagent using gallic acid as a standard according to the method described by Danial and George (1979).

-Total flavonoids were determined accordiong to the method described by Zhuang *et al*. (1992).

-Phenolic compounds were fractionated and identified by HPLC Hewllet Packared (series 1050) according to the method of Goupy *et al.* (1999).

- The antioxidant activity of phenoilc compounds was measured in terms of hydrogen donating or radical scavenging ability, using the stable radical

DPPH (2, 2'-Diphenyl-1-picrylhydrazyl) according to the colorimetric method of Brand-Williams *et al*. (1995).

-Vit. B-complex were determined according to the method described by Batifoulier *et al*.(2005) with slight modification using variable wavelength detector (VWD) instead of florescence detector, VWD set at 280 nm. HPLC Agilent 100 series.

RESULTS AND DISCUSSION

Effect of germination process on gross chemical composition of barley and oat grains

Data in Table (1) reveal no changes occurred in moisture and ash contents of barley and oats grains during germination period. Meanwhile, protein contents (12.15 and 11.13 %) gradually increased with increasing the germination period being 15.24 and 12.96% after three days for barley and four days for oat, respectively. increasment in protein content may be attributed to the dry weight losses through respiration during malting process. These results are in agreement with those reported by **Peterson** (1998). On the other hand, fat contents of barley and oat grains decreased from 3.6 to 1.53 % and 7.5 to 6.1 %, respectively. The decreasment in lipid content probably results in part from lipase catalyzed degradation triacylglycerides to free fatty acids (FFA) and glycerol and the further oxidation of the FFA into non lipid products **(Peterson**, 1998).

Table (1): Effect of germination process on chemical composition of barley and oat grains (on dry weight basis)

*Samples / Constituents %	B	B_1	B_2	B_3	O	O_1	O_2	O_3
Moisture	11.25	11.19	10.95	11.19	10.38	10.23	10.31	10.28
Ash	2.31	2.46	2.77	2.67	4.45	4.62	4.73	4.68
Protein	12.15	12.24	14.15	15.24	11.13	11.61	12.53	12.96
Fat	3.6	3.06	1.93	1.53	7.5	6.6	6.3	6.1
Crude fibers	4.4	3.35	3.47	3.05	11.7	6.8	5.92	5.44
Total sugars	4.32	5.39	10.68	12.3	3.74	4.46	7.44	11.86
Reducing sugars	2.02	3.74	9.2	11.01	2.08	3.03	6.14	10.74
Non reducing sugars	2.3	1.65	1.48	1.29	1.66	1.43	1.30	1.12
Starch	61.30	58.52	49.64	36.22	59.62	56.33	39.21	31.32
Phytic acid	1.07	0.94	0.62	0.48	0.88	0.81	0.53	0.39

B(raw barley grains) **O (raw oat grains)**
B_1 (soaked for 8 hrs.) **O_1 (soaked for 8 hrs.)**
B_2(germinated for 2 days) **O_2(germinated for 3 days)**
B_3(germinated barley for 3 days) **O_3(germinated for 4 days)**

Crude fibers content of barley and oats grains decreased from 4.4 to 3.05 % and 11.7 to 5.44 %, respectively. Whereas, the starch content decreased from 61.3 to 36.22 % and 59.62 to 31.32 % for barley and oats grains, respectively. As shown in Table (1), the total and reducing sugars contents of barley (4.32 and 2.02%) and oats (3.74 and 2.08%) grains increased during germination period being 12.3% and 11.01% & 11.86 and

10.74%, respectively. The data of starch contents are in accordance with those reported by Tian *et al*. (2010) who reported that the reduction of starch content was due to the activity of α – amylase enzymes during germination process and which causes an increase in total sugars. Moreover, the non reducing sugars decreased from 2.3 to 1.29% and 1.65 to 1.12% for barley and oats grains, respectively.

Phytic acid content of barley and oat grains decreased from 1.07 to 0.48 mg/100g and 0.88 to 0.39 mg/100g throughout germination period, respectively. A large number of negatively valued components in the seed such as phytic acid decline with increasing time of germination and the decrease could be attributed to an increase in phytase activity as germination progressed. The data of phytic acid contents are enclosed with those reported by Larsson & Sandberg (1992).

Generally, from the aforementioned data it could be clearly concluded that germination process had a great role on the efficiency of chemical composition of selected cereal grains. Increasing germination period decreased fat, crude fibers and starch contents due to the activities of hydrolysis enzymes.

Effect of germination process on minerals content of barley and oat grains

Data presented in Table (2), show that Mg (36.14 and 54.37 mg/100g) and Na (73.39 and 83.58 mg/100g) contents in raw barley and oat grains increased while at end of germination period being 227.52 & 116.45 mg/100g and 314.23 & 103.48 mg/100g, respectively. Slightly changes in Zn, Mn and Fe contents occurred. On the other hand, Ca content of barley (38.94 mg/100g) increased more than 3 folds during the germination process being 129.84mg/100g after three days. Meanwhile, slightly increased recorded of Ca oat contents (107.56 mg/100g) after four days being 116.45 mg/100g (Table, 2).

Table (2): Effect of germination process on minerals content of barley and oat grains (on dry weight basis)

*Samples / Minerals (mg/100gm)	B	B_1	B_2	B_3	O	O_1	O_2	O_3
Mg	36.14	64.59	134.06	227.52	54.37	59.28	74.24	116.45
Na	73.39	141.61	230.29	314.23	83.58	97.31	100.78	103.48
Zn	0.29	0.32	0.31	0.33	0.36	0.37	0.38	0.47
Mn	0.170	0.185	0.187	0.188	0.314	0.325	0.358	0.457
Fe	0.829	0.817	0.832	0.836	1.11	1.14	1.15	1.16
Ca	38.94	77.21	108.46	129.84	107.56	113.42	114.42	116.45
K	226.86	245.36	270.03	307.52	83.58	85.20	92.91	122.41

***See Table (1)**

Potassium contents increased from 226.86 to 307.52 mg/100g and 83.58 to122.41 mg/100g for barley and oat grains, respectively after the germination process. These results are in agreement with those reported by Hübner *et al.* (2010) who found that minerals content of germinated barley

and oat grains can be influenced by the minerals content of the steeping water.

Accordingly, from the above data it could be concluded that the more germination time, the more minerals content of barley and oat grains was observed, because of phytase activity on phytates which liberates the minerals from phytates complex in free mode.

Effect of germination process on dietary fibers fraction and β-glucan contents of barley and oat grains

Neutral detergent fibers (NDF), acid detergent fibers (ADF) and acid detergent lignin (ADL) were fractionated as well as, cellulose and lignin contents were also determined and the results are shown in Table (3).

Data in Table (3) reveal that NDF, ADF and ADL contents of barley were (18.94, 8.19 and 1.56 %, respectively) and (24.09, 12.48 and 2.75% in oat, respectively). These decreased during germination period being 16.06, 7.19 and 1.11 % for barley after three days and 20.98, 11.86 and 2.38 % for oat after four days, respectively. Whereas, hemicelluloses and cellulose contents decreased with increasing germination period till two days for barley (7.49 and 5.83 %) and three days for oat (6.09 and 6.41 %). After that they recorded 8.87 and 6.08 % for barley and 9.12 and 9.48 % for oat grains, respectively.

Meanwhile, lignin content in barley and oat (0.96 and 1.72 %) decreased during steeping process being 0.61 %in barley and 1.11 % in oat. After that its contents raised till two days in barley being 0.71 % then decreased with increasing the germination period being 0.57 % for barley and 1.52 % for oat (Table, 3).

Table (3): Effect of germination process on dietary fiber fractions and β-glucan contents of barley and oat grains(on dry weight basis)

*Samples / Constituents %	B	B_1	B_2	B_3	O	O_1	O_2	O_3
NDF	18.94	17.14	14.73	16.06	24.09	20.86	14.73	20.98
ADF	8.19	7.28	7.24	7.19	12.48	9.81	8.48	11.86
ADL	1.56	1.17	1.41	1.11	2.75	2.00	2.07	2.38
Hemicelluloses	10.75	9.86	7.49	8.87	11.61	11.05	6.09	9.12
Cellulose	6.63	6.11	5.83	6.08	9.73	7.81	6.41	9.48
Lignin	0.96	0.61	0.71	0.57	1.72	1.11	1.24	1.52
Total β glucan	4.48	4.02	3.86	3.71	3.15	2.94	2.57	2.43
Soluble β glucan	2.77	2.96	3.11	3.21	1.39	1.51	1.81	1.93
Non soluble β glucan	1.71	1.01	0.75	0.50	1.59	1.44	0.76	0.43

***See Table (1)**
NDF: Neutral detergent fiber (Cellulose, hemicelluloses, lignin)
ADF: Acid detergent fiber (Cellulose, lignin) ADL: acid detergent lignin

On the other hand, the total and insoluble β-glucan contents of barley and oat grains (4.48 and 3.15 % &1.71 and 1.59 %, respectively) decreased during germination period being 3.71 and 2.43 % & 0.50 and 0.43 %, respectively (Table,3). The breakdown of β-glucan during germination process caused by β -glucanase enzymes. Soluble β-glucan contents slightly increased in barley and oat during germination from 2.77 to 3.21% and 1.39

to 1.93 %, respectively. The data of β –glucan contents are in accordance with those reported by Hübner *et al.* (2010.)

Generally, β –glucan contents of barley and oat grains slightly declined with increasing the germination time.

Effect of germination process on total phenolic compounds, antioxidant activity and flavonoids contents of barley and oat grains

Some bioactive compounds namely, polyphenols, flavonoids contents and antioxidant activity were determinated and the results are presented in Table (4).

The results in Table (4) show that the total phenolic compounds (0.791 and 0.62 mg/g) and antioxidant activity (3.68 and 4.32 %) of barley and oat grains gradually increased with increasing the germination period being 2.01 and 1.93 mg/g & 9.43 and 11.28 % after three days for barley and four days for oat grains , respectively. Increasing in total phenolic compounds and antioxidant activity may be attributed to the better extractability of phenolic compounds from the kernel structures after germination. In addition, hydrolytic enzymes can lead to the release of bound phenolic compounds, mainly the phenolic acids are associated to lignin and arabinoxylans. The results of total phenolic compounds are in agreement with those reported by Sharma and Singh Gujral (2010). Meanwhile, the increase of antioxidant activity could be due to the development of such non-enzymatic browning products as Maillard products, which can also act as antioxidants, particularly melanoidins. The data of antioxidant activity contents are in accordance with those reported by Dvořáková *et al.* (2008).

The flavonoids content in barley and oat grains (0.563 and 0.46 mg/g) gradually increased with increasing the time of germination process being 1.43 and 1.27 mg/g (Table, 4).

Generally, from the data presented in Table (4), it could be clearly observed that increasing germination period increased total phenolic compounds, antioxidant activity and flavonoids contents.

Table (4): Effect of germination process on total phenolic compounds, antioxidant activity and flavonoids content of barley and oat grains(on dry weight basis)

*Samples / Constituents	B	B_1	B_2	B_3	O	O_1	O_2	O_3
Total phenolics (as gallic acid) (mg/g)	0.791	0.80	1.64	2.01	0.62	0.73	1.56	1.93
Antioxidant activity % (as DPPH)	3.68	4.22	5.43	9.43	4.32	5.93	8.78	11.28
Flavonoids (mg/g)	0.563	0.61	1.15	1.43	0.46	0.55	0.813	1.27

***See Table (1)**

Effect of germination process on phenolic compounds fractions of barley and oat grains

Phenolic compounds of barley and oat grains were separated and identified by HPLC and the results are presented in Table (5).

The results in Table (5) reveal that phenolic compounds of barley and oats varied with the difference in steeping and germination stages. Catechin and pyrogallol were the major free phenolic compounds that existed in raw and germinated barley and oat grains. Catechin (30.98 and 32.60 mg/100g) and pyrogallol (43.05 and 21.49 mg/100g) increased during germination period being 40.17 and 114.93 mg/100g after three days for barley and 189.21 and 159.81 mg/100g after four days for oat grains, respectively. Whereas, gallic acid (0.99 and 0.63 mg/100g), chlorogenic (2.88 and 1.08 mg/100g) and catechol (2.40 and 3.05 mg/100g) were found in traces then, increased gradually during the germination period being 5.11 and 1.17 mg/100g; 23.50 and 22.49 mg/100g and 8.62 and 8.56 mg/100g for barley and oat grains, respectively (Table, 5). P-OH benzoic, ferulic and hespertin were detected after steeping and germination process recording 3.11 and 2.19 mg/100g; 2.46 and 2.29 mg/100g and 4.34 and 2.40 mg/100g for barley and oat, respectively. On the other hand, caffeic and protocatchoic of raw barley and oat grains disappeared during steeping and germination process. These results are in accordance with those reported by Beart *et al*. (1985) who reported that the variation in fraction of phenolic compounds should be caused by an increase of enzymatic activity during steeping and germination processes.

Table (5): Effect of germination process on phenolic compounds fraction of barley and oat grains(on dry weight basis)

*Samples / Phenolic compounds (mg/100g)	B	B_1	B_2	B_3	O	O_1	O_2	O_3
Gallic acid	0.99	2.53	2.77	5.11	0.63	0.68	0.82	1.17
Catechin	30.98	30.92	36.02	40.17	32.60	17.70	72.24	114.93
Pyrogallol	43.05	50.42	178.01	189.21	21.49	30.52	117.97	159.81
Chlorogenic	2.88	5.09	18.81	23.50	1.08	1.30	22.49	29.97
P-OH Benzoic	-	1.37	2.51	3.11	-	1.14	1.24	2.19
Catechol	2.40	2.84	4.23	8.62	3.05	4.92	6.63	8.56
Vanillic	-	6.45	8.15	-	-	1.77	3.31	-
Ferulic	-	0.72	1.00	2.46	-	0.22	0.57	2.29
Hespertin	-	0.41	0.74	4.34	-	0.56	2.22	2.40
Caffeic	0.42	-	-	-	0.98	-		-
Syringic	1.02	2.88	6.38	-	0.86	1.63	3.68	-
P-coumaric	-	-	1.72	-	-	-	-	-
Protocatchoic	2.88	-	-		0.24	-	-	-
Chrisin	-	-	-	-	-	0.38	-	-
Hesperdin	-	-	-	-	-	0.89	-	-

***See Table (1)**

Effect of germination process on vitamin B contents of barley and oat grains

As recorded in Table (6), nicotinic acid (60.82 and 71.23 mg/100g) and Vit. B1 (210.19 and 207.74 mg/100g) were the most abundant Vit. B complex in raw barley and oat grains and they highly increased during germination period more than two folds recorded 120.81 and 145.56 mg/100g & 335.21 and 441.62 mg/100g after three days for barley and four days for oat grains, respectively. On the other hand, folic acid (3.55 and 12.67 mg/100g), pyridoxine (3.02 and 2.11mg/100g), B12 (11.13 and 21.03 mg/100g) and riboflavin (3.17 and 1.48mg/100g) found in small amounts of raw barley and oat grains and also increased to 14.50 and18.83 mg/100g, 32.00 and 20.00 mg/100g, 36.42 and 50.76 mg/100g and 4.13 and 2.24 mg/100g for germinated barley and oat grains, respectively (Table, 6). Increasing of Vit. B complex quantity could be due to the fact that, during germination, seeds synthesized vitamins for its development. These results are in accordance with those of Chavan (1989).

Table (6): Effect of germination process on B complex vitamins content of barley and oat grains(on dry weight basis)

*Samples / Vit. B complex fractions (mg/100g)	B	B_3	O	O_3
Nicotenic acid	60.82	120.81	71.23	145.56
Folic acid	3.55	14.50	12.67	18.83
Pyroxidine (B6)	3.02	32.00	2.11	20.00
Cobalamin (B12)	11.13	36.42	21.03	50.76
Thiamin (B1)	210.19	335.21	207.74	441.62
Riboflavin (B2)	3.17	4.13	1.48	2.24

***See Table (1)**

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تأثير عملية الإنبات على التركيب الكيماوي والمركبات الحيوية النشطة فى الشعير والشوفان

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لاقت الحبوب وخاصة الشعير والشوفان اهتماما حديثا" من الناحية البحثية كما لفتت الإنتباه لاحتوائها على نسبة عالية من الألياف الغذائية وخاصة البيتا جلوكان وبعض المكونات الحيوية التي تلعب دورا" مهما" كمضادات للأكسدة الطبيعية. لذلك أهتمت الدراسة بدراسة التركيب الكيماوي لكل من الشعير والشوفان بالإضافة إلى دراسة تأثيرعمليتي النقع والإنبات لفترات مختلفة على التركيب الكيماوي ومحتواها من المركبات الحيوية وأثبتت النتائج المتحصل عليها أن عملية الإنبات لفترات مختلفة تلعب دورا" مهما" فى زيادة كفاءة التركيب الكيماوي للحبوب تحت الدراسة حيث أظهرت تأثيرا" سلبيا" على نقص محتوى كلا" من الألياف الخام والنشا وذلك بزيادة وقت عملية الإنبات نتيجة نشاط إنزيمات التحلل المائي وخاصة إنزيمات الألفا أميليز مما أدى إلى زيادة محتوى السكريات الكلية. كذلك حدث نقصا" في محتوى حمض الفيتك بزيادة وقت عملية الإنبات. كذلك

أرتفع محتوى البروتين تدريجيا" بزيادة وقت الإنبات ليصبح ١٥,٢٤, ١٢,٩٦% بعد ٣ أيام في الشعير, ٤ أيام في الشوفان على التوالي.

أرتفع محتوى العناصر المعدنية وزادت الكفاءة الحيوية بزيادة وقت الإنبات على العكس من ذلك نقص محتوى البيتا جلوكان في كل من الشعير والشوفان. بزيادة وقت الإنبات زاد محتوى كل من المركبات الفينولية والفلافونيد وزيادة النشاط المضاد للأكسدة وكان كلا" من الكاتشن والبيروجالك هما المركبات الاساسية والاكثر تواجدا فى كل من الشعير والشوفان قبل وبعد عملية الإنبات. كان فيتامين الثيامينوحمض النيكوتينك هما المركبان الأساسيان والأكثر تواجدا" من مجموعة فيتامين ب والذي تضاعف تركيزهما أكثر من الضعف بعد عملية الإنبات .

عامة لعبت عملية الإنبات دورا إيجابيا مهما في زيادة محتوى المركبات الحيوية مثل الفينولات والفلافونيد وزيادة النشاط المضاد للأكسدة والكفاءة الحيوية للعناصر المعدنية الضرورية وإرتفاع محتوى فيتامين ب المركب فى كل من الشعير والشوفان.

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