CHEMICAL CHANGES OF SOYBEANS DURING GERMINATION

S.A. HAFEZ[1], S.A. ISMAEL[2], AND MONA, H.MAHMOUD[1]

1 *Department of Special Food and Nutrition, Food Technology Research Institute, Agric. Research Centre, Giza, Egypt.*

2 *Biochemistry Dept., Faculty of Agriculture, Cairo University.*

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Abstract

In the present study dried and germinated soybean seeds were chemically analyzed and the data obtained for total protein were significantly increased steadly during germination from 37.52% to 41.84, but carbohydrate content were gradually decreased from 25.11% to 18.79%. Trypsin inhibitors and phytic acid were significantly decreased during germination while the protein digestibility was highly increased from 63.83% to 83.51%. Sucrose, galactose, raffinose and stachyose were gradually decreased during germination. The largest molecular weight proteins from 90.5 to 73 KD were present only in mature and 24 hr. germinated soybeans by a percenage of 28.6% and 34.2% of total proteins respectively. Proteins, having moleclar weights from 71 to 96 KD, were gradally decreased from 19.3% in mature seed to 8.89% after the second day of germination. Many proteins with different moleclar weights (64-62, 47, 41 and 22 KD) were present in all stages.Aspartic acid was the major amino acid in dried soybeans (21% of total amino acids) and germinated seeds.

INTRODUCTION

Soybeans (Glycin Max, L.) is an important source of energy and protein around the world, for both animal and human nutrition. Soybean protein is one of the best vegetable proteins, because the essential amino acid pattern of soybean protein complements that of the other protein sources.

The nutritional value of soybean may be limited in part by the presence of undesirable components known as antinutritional factors. These factors include protease inhibitors, lectins, phenolic compounds, phytates and indigestible carbohydrates of raffinose family.

Germination is considered a suitable procedure to improve the nutritional value of soybean by reducing the levels of the antinutritional factors.

Soybean is a good source of dietary protein which ranges from 36% to 45% according to variety, location of cultivation and temperature. It is higher than the protein content of the other legumes (20-30%) and much higher than that of cereals (8-15%). This large quantity of protein in soybeans along with its excellent quality increases its nutritional value, therefore, soybeans have overcome other oil seeds. (Dornbos, 1989; Mohamed and Rangappa, 1992; Zarkadas *et al.*, 1993; Kim *et al.*, (1993).

The carbohydrate portion of soybean seed is about (25% - 30%) on dry weight basis, and it is usually divided into soluble and insoluble fractions. The amount of the soluble carbohydrate in the mature soybeans is about 10% with approximatly 5 % sucrose, 1% raffinose and 4% stachyose.

These amounts vary with variety, maturity, growing conditions and method of analysis (Snyder and Kwon, 1987; Kumar *et al.*, (1992).

The relative percentage of soybeans oil fatty acide are as follows: (10.5-14%) palmitic acid; (4-5.9%) stearic acid; (21.2-29.1%) oleic acid; (39.9-56.4%) linoleic acid; and (3.2-7.8%) linolenic acid (Wilson *et al.*, 1982; Katiyar *et al.*, 1989; Yong and Peng, 1990; Liu and White, 1992).

Phytates are excellent chelators and they easily associated with proteins and their level increase with increasing the protein content. The main disadvantage of soybean products is the binding with several minerals. Zinc is the mineral that seems to be most affected by the presence of phytic acid from soybeans.

The phytic acid content of seeds are decreased during germination, fermentation due to microbial phytases, and autoclaving for 4 hr at 115^{o}C which destroys most of phytic acid. This last technique from a nutritional stand point, would be unaccepttable due to amino acid destruction. (Maga, 1982, Snyder and Kwon, 1987).

Protease inhibitors of soybean include trypsin and chymotrypsin inhibitors. Trypsin inhibitors are proteins with molecular weights ranged from 8000 to 21500. The growth depression to the extent of 40% with pancreatic hypertrophy effects of raw soybean protein fed to rats were attributed to trypsin inhibitors. Germination and seed maturation are known to influence the level of trypsin inhibitors in soybeans (Salunkha *et al.*, 1992).

Raffinose and Stachyose have been implicated as the cause of flatulence and uncomfortable feeling after consuming soyproducts. Sucrose, raffinose and stachyose on

the average represent 60%, 4% and 36% respectively, of the total sugar contents (Snyder and Kwon, 1987).

Trugo *et al.*, (1995) determined the composition of digestible sugars (DS) and non digestibile sugars (NDS) in 20 soybean cultivars grown in Brazil. In addition, a comparison between three different extraction procedures for sugar analysis by HPLC was performed. Total α-galactosides in samples were in the range of (3.9-5.3%), in which stachyose was the main component, while fructose and sucrose varied from (4-6.1%) on dry weight basis. Germination of soybeans for three days decrease raffinose and stachyose, while an increase in sucrose content was found, Trugo *et al.*, (1995). The nutrition improvement of germinated soybeans may be due to the decrease in trypsin inhibitor and the reduction of oligosaccharides that means much less flatulence (Suberbie *et al.*, 1981).

Flatulence is generally attributed to the fact that human's intestines do not contain α-galactosidases which are necessary for hydrolyzing the α-galactoside linkages of raffinose and stachyose to yield readily absorbable sugare. the flatus-producing factors in soybeans are heat-stable and several attempts have been made to eliminate these factors by enzymatic hydrolysis (Liener, 1981). Although treatment of soybeans with mold enzmes or yeast fermentation virtually eliminated stachyose and raffinose. Germination has also been reported to cause a marked reduction in the level of oligosaccharides.

Usually, no ascorbic acid is found in the dry soybean seeds. Germination of soybeans for three days decrease raffinose and stachyose, while an increase in sucrose conent was found, Trugo, *et al.*, (1995). The galactose-containing oligosaccharides (stachyose and raffinose) are metabolized during sprouting. At the same time, trypsin inhibitor activity is decreased and protein digestibility is increased (Synder and Kwon, 1987). Kataria, *et al.*, (1989) reported that the antinutrient concentration of phytic acid declined during germination and that antinutrient concentration of phytic acid declined during germination and that may be attributed to phytase activity in germinated seeds which subsequently improved the protein digestibility. Germination of legumes and grains seemed to be the most effective method of getting rid of these antinutrients.

Lee and Karunanithy, (1990) studied the effect of germination on total protein, amino acid and phytic acid contents of soybeans. The increase in total crude protein content was > 21%. There was marked increase in total essential amino acids 76% and

the phytic acid content of the beans were drastically reduced (<0.2%) mainly due to leaching into soaking water. On the contrary Danisova *et al.*, (1995) determined the effect of germination on soybeans nutrients and they found no significant change in total protein, however, the essential amino acid content was increased (5-23%).

Bau *et al.*, (1997) studied the effects of germination on the chemical composition, biochemical constituents and antinutritional factors of soybean. The protein content was increased significantly after 5 days of germination. this increase may be due to synthesis of new enzyme proteins or a compositional change following the degradation of other constituents. The major legume storage proteins were globulins and vicilin. In soybeans, these proteins have been called glycinin and β-conglcinin.

Sudhakar *et al.*, (1991) studied the changes in lipid content during the first 7 days of germination. Total lipids content was decreased in cotyledons, hypocotyls and roots and this was accompained by a rise in phospholipid content. Free fatty acids, glycerol and cholesterol were decreased from the first to the seventh day of germination and this may be due to their increase in lipase activity.

The protein fractionation pattern obtained on polyacrylemide gel elecrophorasis (SDS-PAGE) demonstrated a considerable protein break-down during germination between day 1 and 2. The protein bands with molecular weights between 97.400 and 31.500, mainly β-conglcinin and glycinin-subunits, started to disappear between day one and day two. Starting at day two of germination, protein band had molecular weights between 25000 and 35000. Germination of soybean increased the in-vitro digestability of their proteins, and the degraded Proteins from germination of soybeans were digested better than the protein in their native form. It is considered that the better in vitro digestability of the germinated seed proteins could be induced by the combined effect of the decrease in lectin content and trypsin inhibitor activity or/and a greater susceptibility to enzymatic attack of the degraded proteins formed during germination.

This study aims to follow the chemical changes that happens for antinutritional factors (trypsin inhibitors, phytic acid, raffinose family), fatty acids, amino acids, proteins and protein digestability during the germination of soybeans.

MATERIALS AND METHODS

Soybean variety (clark) was obtained from Legumes Research Department, Field Crops Research Institute, ARC. Giza, Egypt.

Seeds were washed in a 0.5% sodium hypochlorite solution for 20 min. at room temperature (23^{o}C), rinsed throughly with tap water, and immersed in deionized water for 6 hr. Seeds of uniform size were selected and placed on four layers of wetted filter papers in petri dish. Germination of seeds were carried out in the dark, at 27^{o}C. Seeds and filter papers were rinsed once daily with fresh deionized water (Kuol *et al.*, 1988).

Total hydrolyzable carbohydrates were determined as glucose according to phenol-sulphoric acid method described by Dubois *et al.*, (1956). Crude protein, crude oil, fiber, ash and moisture were determined according to (A.O.A.C., 1990). The in vitro protein digestility was assessed by employing pepsin and pancreatin as described by Santosh and Chauhan (1986). The nitrogen contents of the sample and supernatant after digestion were determined by micro kjeldahl methods.

Trypsin inhibitor was determined according to the method described by Hamerstand *et al.*, (1981) phytate was extracted according to the procedure describe by Camire and Clydesdole (1982) and modified by Mohamed *et al.*, (1986).

Sugars were determined by high performance liquid chromatography (HPLC) according to the method of Knudsen (1986). The conditions used were as follows: Column, (Aminx 300 X 87 mm); mobile phase deionized water, flow rate, 0.6ml/min; temperature, 70^{o}C and detector refractive index.

Fatty acids of soybeans were separaed according to the method of Farag *et al.*, (1990). The gas chromatographic condition used for isothermal work were as follows: column temperature 190^{o}C, detector temperature 250^{o}C, and injector temperature 300^{o}C, nitrogen flow rate 30ml/min., hydrogen flow rate 33 ml/min.,, and air flow rate 500 ml/min.

Protein extracts of samples were identified by SDS polyacylamide gel electrophorasis (SDS-PAGE) according to the method of Laemmli (1970)

Amino acid of mature and germinated soybeans were determined using HPLC-Pico-Tag according to Jones *et al.*, (1987).

Table 4. Menirals content of weaning food blends (Per 100 g dry weight.)

RESULTS AND DISCUSSION

Data presented in table 1 and fig. 1 show that the total proteins were significantly increased steadily during germination of soybeans from 37.52 to 41.84%. After 4 days of germination the net increase in protein content was 11.5%. It is mainly due to formation of new cells during germination of soybeans. This increase may be also due to synthesis of new enzymes proteins or composition changes following the degradation of other constituents (Bau *et al.*, (1997). This result is in agreement with the results of Zhang and Luo (1994).

The carbohydrate contents in sprouts gradually decreased from 25.11% in mature soybeans to 18.79% after the fourth day of germination. The great decline in the carbohydrate content was seen during the second day of germination (20%). These data agree with those reported by Bau *et al.*, (1997) who reported that total carbohydrattes especially the methanol soluble carbohydrates diminished gradually as germination progressed.

In the present study, total lipids and ash contents were not changed during germination similar to the results obtained by Donangelo *et al.*, (1995), but contrary to the results published by Chandrasiri *et al.*, (1991) who found that the lipid content at the end of 5 days, of lipid loss reached 19.8% compared to mature seeds.

Trypsin inhibitors, phytic acid (antinutritional factors) and protein digestibility were determined in soybeans during germination, as shown on table 2 and fig. 2. These data indicate that phytic acid content was gradually decreasd from 1.82 to 1g/100g on the fourth day. The decreąsing percentage was 45%. Reddy *et al.*, (1982) have observed a reduction in phytic acid during germination of different legume seeds apparently as a results of large increase in phytase activity. A 17% decrease of phytic acid in soybean seeds after 5-days of germination was reported recently by Bau *et al.*, (1997).

The data also show that the trypsin inhibitor content of soybean was decreased steadily from 25.21 in mature soybeans to 21.24 mg / g in germinated seeds after 4 days. The present results are slightly higher than that obtained by Roozen and De-Groot (1989) who found that the content of trypsin inhibitor in mature soybeans was 20.4 mg/g dry seeds. The protein digestibility of soybeans was increased gradually from 63.83% in dry soybeans to 81.51% in germinated soybeans after 4 days. The large increase in digestibility was observed during the second day of germination. The presént results are confirmed by several investigators (Bates *et al.*, 1977, Smith and

Circle, 1972, Snyder and kwon, 1987. The increase in protein digestibility of germinated soybeans is mainly due to increase of the proteolytic enzymes, synhesis of new enzymes required for seedling growh, considerable protein breakdown, composition changes following the degradation of protein and the decrease of trypsin inhibitor activity (Bau *et al.,* 1997).

The data of table 3 and fig. 3 indicate that sucrose, raffinose and stachyose content were diminished during the germination period. A large decrease in stachyose and raffinose contents were observed during the second day of germination, while the sucrose conent greatly decreased during the third day of germination.

On maturation, soybeans contain about 4.72% galacttoside sugars which is slightly lower than (5.3-65.6%) that were obtained by Kuo *et al.,* (1988).

These findings confirm the fact that, stachyose and raffinose are degraded progressively, as found by Bau *et al.,* (1997). The level of glucose increased as germination progressed to 96 hr., which could be explained by the cumulative of sucrose, raffinose, and stachyose (Chandrasiri *et al.,* (1991). Recentuly, Kuo *et al.,* (1990) reported that during germination soybeans convert oil and soluble oligosaccharides, such as raffinose into sucrose which is utilized by axes for rapid expansion and growth. Prior to utilization, sucrose must be metabolized into simple sugars, a process that is accomplished by a large increase of inverase activity in germinated soybean with a large increase in glucose and fructose in the tissues.

The greatest conent of fatty acid in germinated or mature soybeans was linoleic acid (43.75-53.73%). as shown in table 4 and fig. 4. In the present study, the fatty acids composition of dry soybeans is similar to that obtained by Singh *et al.,* (1968). Palmitic acid content was increased during the first day of germination and then slowly decreased. The same trend was obtained by Singhi *et al.*, (1968). Linoleic acid content was increased gradually from 43.74% in mature soybeans to 53.73% after the fourth day of germination. The data show also that linoleic acid content slightly decreased during germination. The proportions of stearic and oleic acids did not change as germination progressed. Singh *et al.,* (1968) found that the ratio between stearic: oleic acids is about 1:7 in mature and germinated soybeans. The previous results suggest that linoleic acid is very important fatty acid during germination of soybeans.

Data preanted in table 5 and fig. 5 indicate that the largest molecular weight proteins, from 90.5 to 73 KD, were anly found in dried soybean seeds and 24hr germinated soybeans by a concenration of 28.6% and 34.2% respectively and were com-

pletely absent in the other germinated soybeans. It is shown that these proteins may play an important role as amino acid reservoir in dried seeds. Therefore, during progressing of germination these proteins may be completely hydrolysed to free amino acids which could be used in the formation of new proeins and enzymes necessary for different processes of germination.

Also, results show that proteins, having molecular weightts from 71 to 69 KD, were gradually decreased from 19.3% in dried seeds to 5.89% after the second day of germination, then gradually increased to 12.76% at the fourth day of germination. These proteins may also act as an amino acid reservoir in dried seeds and new proteins or enzymens having the same molecular weights may be formed after the third day of germination and increased through progressive germinattion. These new proteins and enzymes are of important various metabolic pathways during the germination process. This suggestion was confirmed by the present data, in which new proteins with molecular weight 67, 55, and 46 KD were present only at the fourth day of germination and they did not appear in dried seeds or during the first three days of germination. The percentages of these proteins were 7.41%, 6.31% and 14.14% respectively. In contrast, two types of proteins (59 and 51 KD) were present in dried seeds and the first three days of germination and were completely absent at the fourth day of germination. There were many proteins with different molecular weights (64-62, 47, 41 and 22 KD) prsent in all stages of germination, in addition to the dried seeds. The smallest molecular weight protein (22 KD) was gradually increased during the germination progress and their concentration were doubled after one day of germination, also several proteins were detected at the second day of germination (45-43 KD), while another proteins were present till the second day of germination and then they disappeared (27 KD). Also, new proteins were deteced only at the second day of germination (23 KD).

Data presented in table 6 show that aspartic acid is the major amino acid in dried soybean and germinated seeds. It constitute about 21% of total amino acid in dried soybeans and increased to 33.5%, 29.8%, 41.1% and 29.7% after one, two, three and four days of germination, respectively. Glutamic acid had the same trend of asparic acid and it constituted about 14%, 15.8%, 15.5%, 16.2%, and 21.6% of total acids, respectively. These acidic amino acids comprised one third of total amino acid in mature soybeans and they increased to more than one half of total amino acids in germinated soybeans after 3 and 4 days of germination. Although, these compounds are not high energy compound such as ATP, they are usually good reservoirs for both energy and nitrogen required for the germination process (Martin *et al.*, 1985).

Table.1 Chemical composition of mature and germinated soybeans after 1, 2, 3, or 4 , days of germination (% on dry weight basis)

Sample Content	***Mature***	***Germinated soybeans***				***LSD***	
		24 hr	***48 hr***	***72 hr***	***96 hr***	**0.01**	**0.05**
Crude protein	37.52±0.33	38.52±0.10*	39.95±0.05*	41.12±0.20*	41.84±0.08*	0.38	0.27
Lipid	23.49±0.29	23.52±0.38	23.48±0.29	23.22±0.41	23.12±0.32	-	-
Total hydrozable carbohydrates	25.11±0.56	23.94±0.42*	20.07±0.19*	19.19±0.96*	18.79±0.33*	1.32	0.96
Ash	6.06±0.05	6.07±0.08	6.06±0.10	6.0±0.10	5.99±0.15	-	-
Crude fiber	7.89±0.15	7.96±0.05	9.12±0.14*	9.57±0.07*	10.43±0.07*	0.46	0.33

Each value is a mean of 5 samples ± SE
** significant at 0.05*

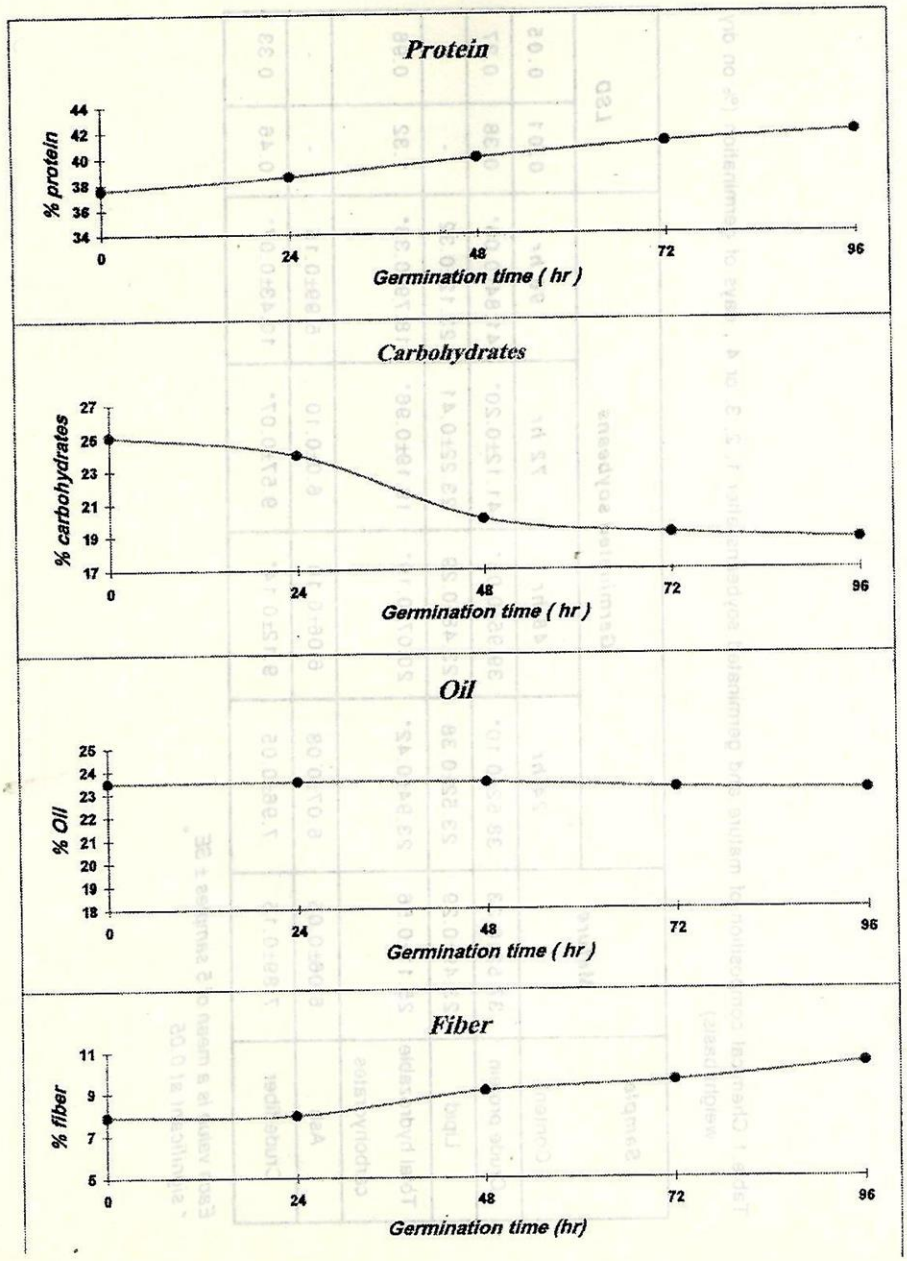

Fig 1. Changes of protein, carbohydrates, oil, and fiber during germination of soybean

Table 2. Changes of soybean anti-nutritional factors (trypsin inhibitors and phytic acid) and protein digestibility during germination for 1, 2, 3, or 4 days.

Soybeans	*Phytic acid g/100gm*	*Trypsin inhibitors Mg/gm*	*Protein digestiility (%)*
Mature	1.82±0.12	25.21±0.18	63.83±2.13*
Germinated for (24hr)	1.68±0.04	23.99±0.41*	68.91±2.30
Germinated for (28hr)	1.45±0.09	22.52±0.16*	76.43±0.77*
Germinated for (72hr)	1.26±0.08	21.52±0.04*	81.39+1.12
Germinated for (96hr)	1.0±0.12	21.24+0.07*	83.51+0.58*
LSD (0.01)	0.19	0.48	3.23
LSD (0.05)	0.14	0.35	2.34

Each value is a mean of 5 samples ± SE
** significant at 0.05*

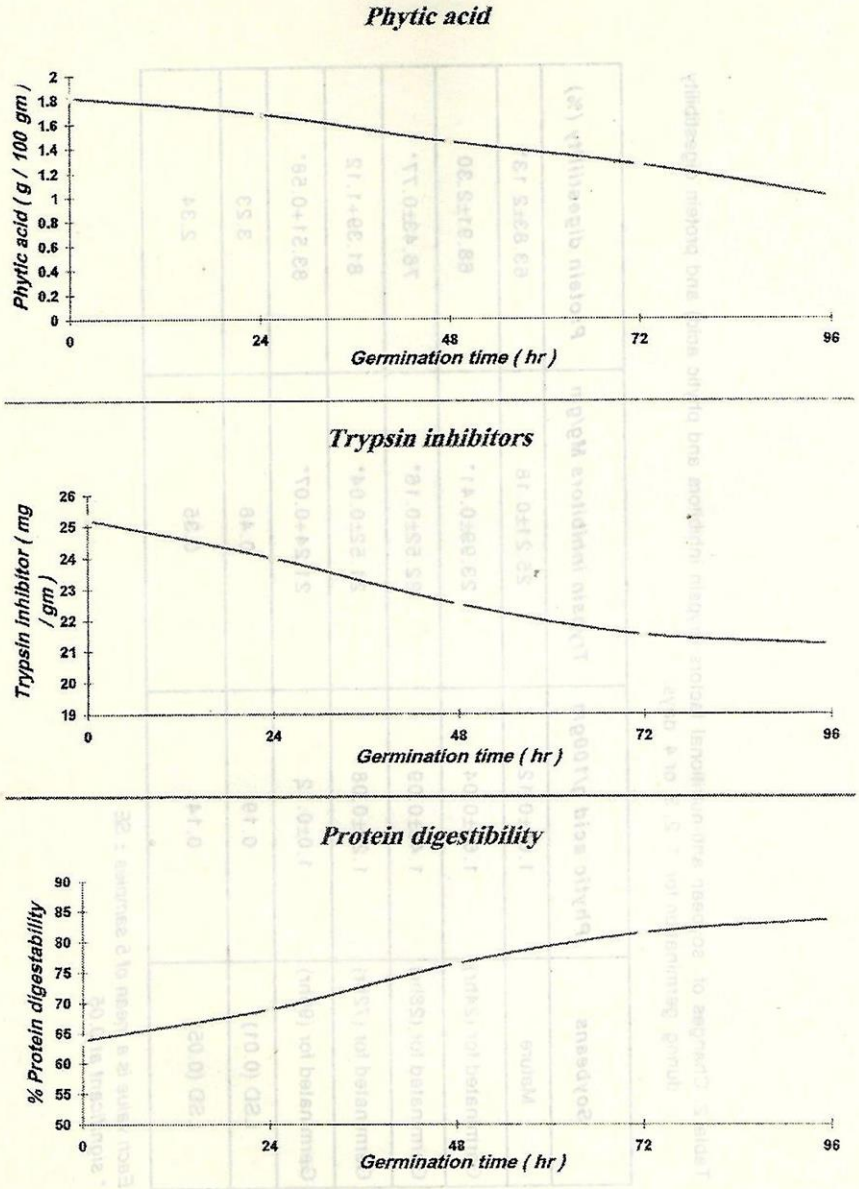

Fig 2. Changes of phytic acid, trypsin inhibitors, and protein digestability during germination of soybean.

Table 3. Changes of sugars during germination of soybeans for 1, 2, 3, and 4 days .

Soybeans	Sucrose	Galactose	Glucose	Stachyose	Raffinose	α-glactosides	Total	ds/nds
Mature	2.44	0.57	-	4.10	0.62	4.72	7.73	0.64
Germinated for (24hr)	2.52	0.59	0.26	3.87	0.50	4.37	7.74	0.77
Germinated for (28hr)	2.05	0.55	0.42	3.2	0.27	3.47	6.51	0.87
Germinated for (72hr)	0.93	0.53	0.53	3.11	0.24	3.35	5.34	0.59
Germinated for (96hr)	0.34	0.41	0.51	2.41	0.17	2.58	3.84	0.49

ds/nds, digestible and absorbed sugars (sucrose, galactos and glucose) non-digestible sugars (stachyose and raffinose).

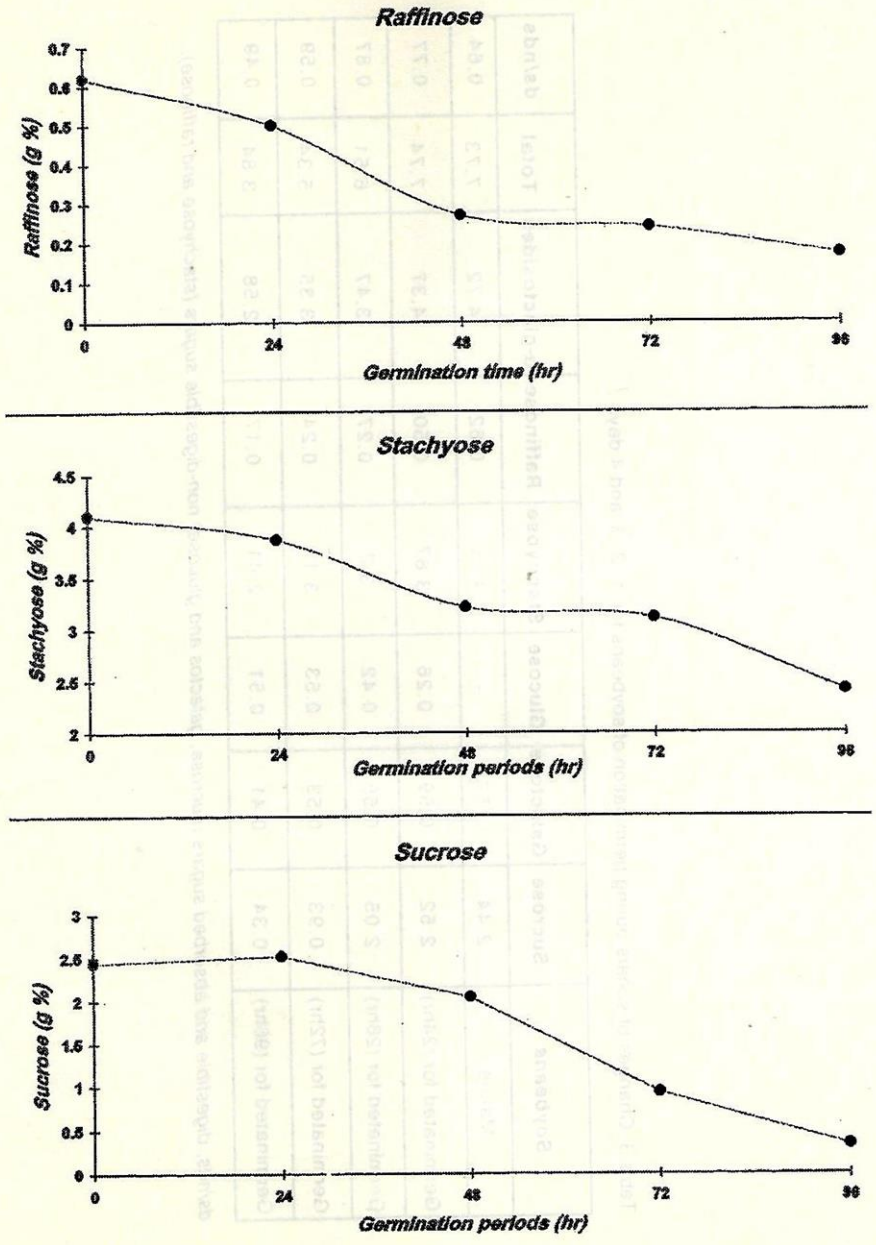

Fig 3. Changes of stachyose, raffinose and sucrose during germination of soybean.

Table 4. The relative percentages of fatty acids in extracted oils from mature and germinated soybeans for 1, 2, 3, or 4 days.

Fatty acid	*Mature*		*Germinated soybeans*							
			24 hr		*48 hr*		*72 hr*		*96 hr*	
	PRT	*Conc.(%)*	*PRT*	*Conc.(%)*	*PRT*	*Conc.(%)*	*PRT*	*Conc.(%)*	*PRT*	*Conc.(%)*
Plamitic acid (16:0)	1	17.95	1	19.36	1	15.42	1	13.09	1	11.23
Stearic acid (18:0) Oleic acid (18:0)	1.19	29.58	1.19	30.49	1.19	28.84	1.20	27.06	1.21	28.73
Linoleic acid (18:2)	1.26	43.74	1.26	43.85	1.27	50.52	1.27	53.11	1.28	53.73
Linolenic acid (18:3)	1.35	8.73	1.35	6.26	1.35	5.52	1.38	6.31	1.38	6.31

RRT is a relative retention time.

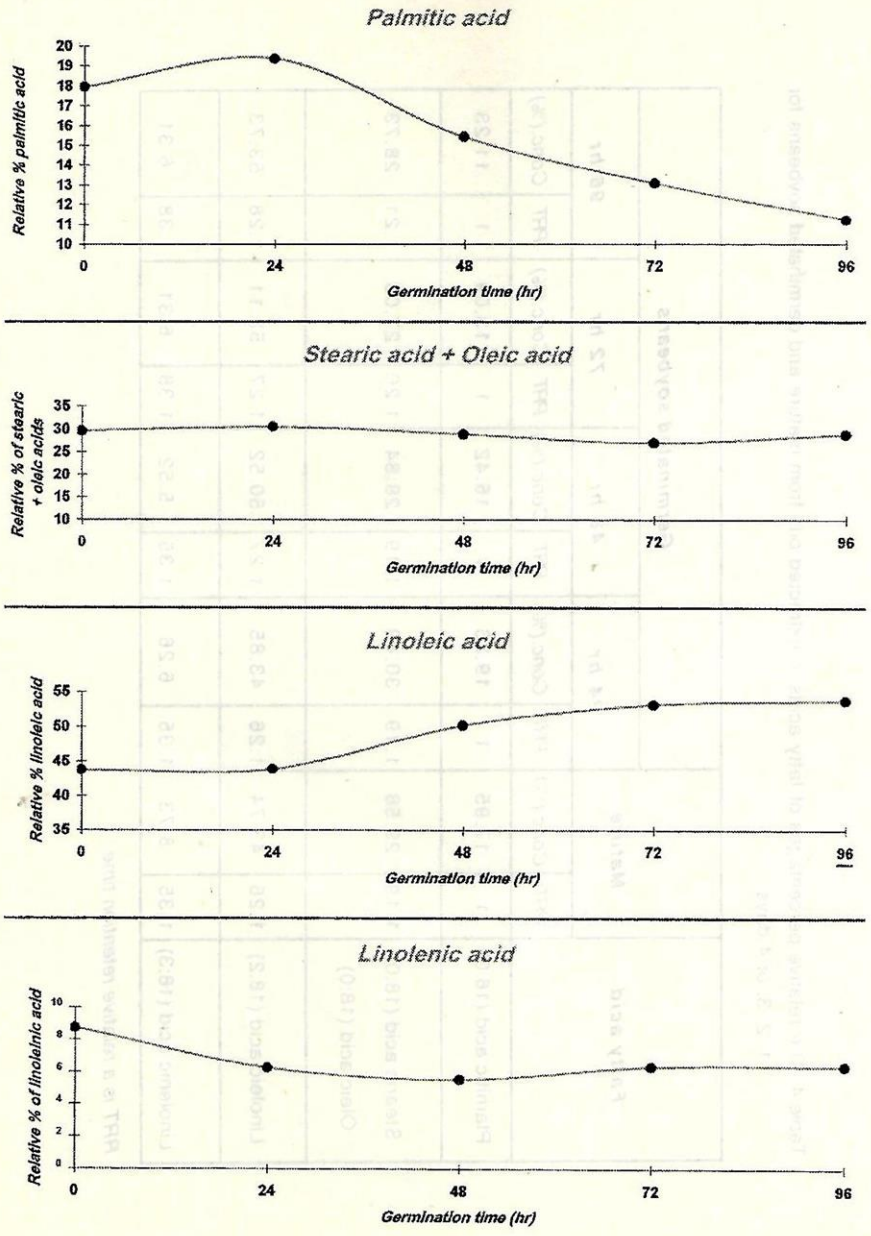

Fig 4. The relative percentages of fatty acids in soybean oil and germinated soybean for 1 , 2 , 3 , or 4 days.

Table 5. Protein patterns of soybeans during germination.

Number of fraction	MW	Mature	Grerminated soybeans For			
			24hr	28hr	72hr	96hr
		Conc. (%)	conc. (%)	conc. (%)	conc. (%)	conc. (%)
1	90.500	3.89	4.05	-	-	-
2	88.000	4.44	4.02	-	-	-
3	83.000	4.95	5.06	-	-	-
4	79.000	4.99	10.76	-	-	-
5	76.000	5.18	5.26	-	-	-
6	73.000	5.15	5.06	-	-	-
7	71.000-96.000	19.31	15.8	5.89	8.14	12.76
8	67.000	-	-	-	-	7.41
9	64.000-62.000	5.84	9.29	8.93	9.32	7.99
10	59.000	6.89	7.09	10.10	10.14	-
11	55.000	-	-	-	-	6.31
12	51.000	6.27	6.52	9.04	9.22	-
13	47.000	7.18	6.35	8.8	9.7	8.94
14	46.000	-	-	-	-	14.14
15	45.000-43.000	-	-	7.78	22.73	13.93
16	41.000	4.65	4.03	5.83	7.18	5.75
17	39.000	4.97	-	5.31	-	-
18	27.000	4.92	3.89	10.12	-	-
19	25.000	-	-	6.67	-	-
20	22.000	11.33	15.77	21.52	23.55	22.76

MW: The molecular weight of a band

Table 6. Total amino acid concentration of germinated soybeans for 1 , 2 , 3 , and 4 days (% on dryweight basis).

Amino acids	Mature	Germinated soybeans			
		24 hr	*48 hr*	*72 hr*	*96 hr*
Essential amino acids					
Theronine	1.31	1.19	2.11	0.89	0.44
Valine	1.49	0.64	1.19	0.98	1.06
Methionine	0.39	0.24	0.28	0.30	0.18
Isoleucine	1.86	0.55	0.50	0.75	0.87
leucine	1.36	0.45	0.40	0.49	0.68
Phenylalnine	0.95	0.72	0.81	1.14	0.73
Hstidine	1.76	2.22	2.17	1.029	1.49
Lysine	3.50	3.3	2.75	3.46	3.49
Arginine	1.51	1	2.16	0.79	1.76
Non-essential amino acids					
Aspartic	7.29	12.09	11.1	15.88	11.71
Serine	0.65	0.39	0.76	0.47	0.88
Glutamic	4.81	5.69	5.76	6.27	8.51
Glycine	0.90	1.06	1.33	1.15	1.52
Proline	0.37	0.57	0.89	0.17	0.44
Cystine	4.65	1.76	1.28	1.23	3.28
Alanine	0.89	1.05	1.02	0.13	0.05
Tyrosine	1.01	2.6	2.69	3.24	2.37

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التغيرات الكيميائية لفول الصويا اثناء الانبات

صائب عبد المنعم حافظ ١ ، سمير عبد المنعم اسماعيل ٢ ،
مني حنفى محمود ١

١ معهد بحوث تكنولوجيا الأغذية - مركز البحوث الزراعية -الجيزة - مصر.

٢ كلية الزراعة - جامعة القاهرة

تهدف هذه الدراسة إلى معرفة تأثير الانبات على مكونات فول الصويا من الكربوهيدرات والبروتين و الزيت والالياف والرماد والبروتينات القابلة للهضم والاحماض الدهنية والاحما الامينية وتفريد بروتينات فول الصويا كذلك تأثير عملية الانبات على عوامل مثبطات التغذية (حمض الفيتيك، مثبطات انزيم التربسين والأليجوسكاريدز) .

وقد وجد ان عملية الانبات لها تأثير على زيادة نسبة البروتين من ٣٧,٥٢ ٪ إلى ٤١,٤٨ اما الكربوهيدرات فقد انخفت من ٢٥,١١٪ الى ١٨,٧٩٪.

وبالنسبة لعوامل مثبطات التغذية فقد وجد نقص فى مثبط انزيم التربسين وكذلك حمض الفيتيك مع حدوث ارتفاع فى نسبة البروتينات القابلة للهضم من ٦٣,٣٨٪ الى ٨٣,٥١٪ كما وجد ايضا نقص فى سكرى الرافينوز والاستاكيوز.

وبالنسبة لبروتينات فول الصويا التى تم تفريدها بواسطة الإلكتروفوريسس فقد وجد ان اكبر وزن جزيئى كان من ٩٠,٥ الى ٧٣,٠٠ كيلو دالتون فى البذور الناضجة والمنبتة لمدة ٢٤ ساعة بنسبة ٢٨,٦٪، ٣٤,٢٪ من البروتين الكلى والبروتينات ذات الوزن الجزائيى من ٧١ الى ٦٩ كليو دالتون نقصت من ١٩,٣٪ فى البذور الناضجة الى ٨,٨٩٪ بعد ٤٨ ساعة من الانبات وبروتينات كثيرة ذات اوزان جزيئية ٦٤ ، ٦٢ ، ٤ ، ٤١ ، ٢٢ كليو دالتون كانت موجودة فى كل المراحل (البذور الناضجة و المنبتة (١ ، ٢ ، ٣ ، ٤ يوم)

الحامض الامينى أسبارتك كان هو السائد فى البذور الناضجة ٢١,٧٪ بالنسبة لمجموع الاحماض الامينية وكذلك البذور المنبتة وكانت اعلى نسبة ٤١,١٪ بعد ثلاثة ايام من الانبات .