Archives of Agriculture Sciences Journal
Print ISSN: 2535-1680
Online ISSN: 2535-1699

ARCHIVES OF AGRICULTURE SCIENCES JOURNAL

Volume 5, Issue 3, 2022, Pages 261–274

Available online at www.agricuta.edu.eg

DOI: https://dx.doi.org/10.21608/aasj.2022.286228

Identification of faba bean (*Vicia faba* L.) protein by electrophoresis

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Abstract

The seeds of fifteen faba bean varieties and genotypes were used in this study; Giza 716, Giza 843, Noubariaa 3, Wady 1, Sakha 1, T. W, hybrid 21, hybrid 22, hybrid 23, hybrid 24, Sakha 4, Noubariaa 1, Giza 40, Missr 1 and Giza 3. The chemical composition of all the previously mentioned varieties and genotypes was done. Results indicated that, carbohydrate content ranged from 51.11-58.15%, protein content ranged from 24.60%-30.68%, moisture from 9.07-10.57%, fat content from 1.54- 2.70% and ash content from 1.38 - 4.16%. Proteins were fractionated by Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis (SDS–PAG). Results revealed that Giza 3, Giza 40, Sakha 4, Noubariaa 1 and T.W were resolved into 8 bands, Giza 716, Giza 843, hybrid 22 and Missr1 were resolved into 9 bands, while hybrid 24, hybrid 23, Wady 1, and Sakha 1 were resolved into 10 bands. Also, hybrid 21 and Noubariaa 3 were resolved into 11 bands. The molecular weight of protein subunits ranged between 15.00 and 352.50 kDa.

Keywords: faba bean, gel electrophoresis, SDS–PAG, molecular weight, dodecyl sulfate polyacrylamide.

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1. Introduction

Faba bean (*Vicia faba* L.), commonly named as broad bean, horse bean, windsor bean, field bean, tick bean (small types), taxonomically belongs to the section faba of the genus Vicia under Papilionaceae of Leguminosae (recently Fabaceae family). Four subspecies of the bean, namely, minor, equine, major and paucijuga (Cubero, 1973). The faba bean (*Vicia faba* L.) of the first legume crops in Egypt according to cultivated area, faba bean is important due to its high nutritional value because it includes a high percentage of protein amounting to 28% and carbohydrate 58% as well as many vitamins. Cultivated faba bean also increases the nitrogen content in the soil and fix nitrogen at a rate of 200 kg/faddan (feddan = 4200 m² = 0.420 hectares = 1.037 acres). Faba bean (*Vicia faba* L.) is one of the oldest crops and ranks the sixth in production among the different legumes grown in the world after soybean, peanut, beans, peas, and chickpeas. Faba bean is a popular legume food with high yield capacity and high nutritional value. It is widely used in the Mediterranean region as source of protein in both human and animal nutrition. Also, it is a popular breakfast food and used as vegetable green or fresh canned. In Egypt, faba bean is one of the most important pulse crops cultivated due to the richness of seed protein content. Also, broad bean could be eaten in several forms, *i.e*., stewed broad bean, broad bean cakes, stewed broad bean paste, and germinated broad bean soap. Therefore, there is a need to increase its production by expansion through newly reclaimed areas. The most important organic components of faba bean seeds are proteins (20–41% of seed dry matter) and carbohydrates (51–68% of seed dry matter), which depend on cultivars. Most of these proteins comprise of globulins (79%), albumins (7%), and glutelins (6%) (Hossain and Mortuza, 2006). The seed of broad bean (*Vicia faba* L.) is a legume seed used as a source of proteins in different regions around the world for human and animal consumption because its protein content oscillates to around 24–32% (Olvera *et al*., 2001; Waldroup and Smith, 1989). This legume seed has other important nutritional compounds, such as fiber, minerals, and vitamin B complex (Agustin and Klein, 1989). The quality of this protein appears to be limited by the low content in sulfur-containing amino acids, tryptophan, valine, isoleucine, and threonine. The main anti nutritional factors contained in the seed are tannins and two glucosides as pyrimidine derivatives namely vicine [2, 6 diamino-4, 5-dihydroxy pyrimidine, 5 (B-glycopyransoide)], and convincing [2, 4, 5-trihydroxy-6-amino pyrimidine, 5 (B-D glycopyransoide)]. These two glucosides are also believed to be responsible for causing favism in some genetically susceptible humans consuming faba bean that have deficiency of erythrocytic enzyme glucose-6- phosphate dehydrogenase activity (G6PD) (Beutler *et al*., 1996;

Corchia *et al*., 1995). This enzyme is involved in the pentose phosphate pathway (Frank, 2005). G6PD converts glucose-6- phosphate into 6-phosphoglucono-d-lactone and is the rate limiting enzyme of this metabolic pathway that supplies reducing energy to cells by maintaining the level of the co-enzyme nicotinamide adenine dinucleotide phosphate (NADPH). The NADPH in turn maintains the supply of reduced glutathione in the cells that is used to form free radicals that cause oxidative damage. People with G6PD deficiency are therefore at risk of hemolytic anemia in states of oxidative stress (Gaskin *et al*., 2001). Therefore, this study was carried out to identify faba bean proteins by gel electrophoresis (SDS–PAG) and determine the molecular weight, as well as to estimate the chemical components of different varieties and genotypes of faba bean in order to make a chemo-classification of these varieties and genotypes.

2. Materials and methods

2.1 Materials description

The seeds of fifteen faba bean varieties and genotypes were used: Ten of them were obtained from Sides Agricultural Research Center, Beni Suef governorate, Egypt, and these items were: Giza 716, Giza 843, Noubaria 3, Wady1, Sakha 1, T.W, Hybrid 21, Hybrid 22, Hybrid 23 and Hybrid 24. Four varieties of faba beans were obtained from Al-Matana Agricultural Research Center, Qena governorate, Egypt, and they were: Sakha 4, Noubariaa 1, Giza 40 and Missr 1. The Giza 3 variety was obtained from Mallawi Agricultural Research Center, Minia governorate, Egypt. Table (1) shows the pedigree of different varieties and genotypes of faba bean used in this study.

Table (1): Names and pedigree of the faba bean varieties and genotypes used in this study.

Genotypes and varieties	Pedigree
Giza 716	461/442/83 × 503/453/83
Giza 843	561/2076/85 × 461/845/83
Hybrid 24	Giza 843 × Missr3
Hybrid 23	(Giza 843 × Acurs) × Baraca
Hybrid 22	Giza 843 × L.T.C. En. No.13/2009
Hybrid 21	Almeda × Missr 1
Noubariaa 3	Land races
Wady1	Rena Blanca × T.W.
Sakha 1	620/283/85 × 716/724/88
T.W.	Mutant of individual Sudan Plant
Giza 3	By crossbreeding between Giza 1 and imported 29
Noubariaa 1	By individual selection of the genus Giza Blanca
Missr1	by cross Giza 3 × 123/45/76
Sakha 4	Sakha 1 × Giza 3
Giza 40	By individual selection of the variety Rabiya 40

2.2 Sample preparation

The seeds were peeled, and the husk was separated from the contents of the seed (pulp) manually. Table (2) shows the weight of one hundred seeds, as well as the weight of the entire sample before separation (weight 100 seeds), weight of pulp, and the weight of hull. the samples were ground using a mixer to obtain flour and were kept in polyethylene bags in the refrigerator until chemical analysis.

Table (2): The weight of one hundred seeds (seed index), weight of pulp and weight of hull for the faba bean varieties and genotypes used in this study.

Sample	Sample weight	Pulp weight	Hull weight	Weight 100 seeds
Giza 716	10.00	8.59	1.44	100.00
Giza 843	10.12	8.79	1.31	101.20
Hybrid 24	10.09	8.69	1.39	100.90
Hybrid 23	10.45	9.03	1.40	87.16
Hybrid 22	10.63	9.25	1.38	95.67
Hybrid 21	10.24	8.86	1.37	112.64
Noubariaa 3	10.56	8.74	1.32	105.60
Wady1	10.03	8.67	1.37	100.30
Sakha 1	10.07	8.62	1.46	90.63
T.W.	10.18	9.03	1.15	53.60
Giza 3	10.55	9.20	1.31	105.50
Noubariaa 1	10.58	9.07	1.50	105.80
Missr 1	10.07	8.84	1.23	100.70
Sakha 4	10.03	8.77	1.25	100.30
Giza 40	12.58	10.95	1.64	73.97

2.3 Methods

2.3.1 Proximate composition analysis

The chemical composition including moisture, ash, fat, protein, total carbohydrate and crude fiber of bean seed flour was performed using FOSS 1650 DA/NIR at The Central Laboratory, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.

2.3.2 Protein electrophoresis SDS-PAGE

2.3.2.1 Preparation of sample

Faba bean seeds were separated, then the pulp was ground by a blender to obtain bean flour.

2.3.2.2 Protein extraction

Ten grams of seed cake was dispersed in 100 ml acetate-buffer solution and the pH was adjusted to pH=4 by HCL 1 N. The second portion of seed cake (10 g) was dispersed in 100 ml in phosphate-buffer solution, then the pH was adjusted to be pH=7 by NaOH 0.1 N. A third portion (10 g) of seed cake was dispersed in 100 ml in phosphate-buffer solution with pH=11 by NaOH 0.1 N. Three solutions were placed on a mild magnetic stirrer for an hour, then placed in a centrifuge for 6 minutes at 4000 rpm. The

supernatants were used for protein assay. The depositions of dissolved protein in the alkaline pH were achieved by reducing HCl acid while the dissolved protein in the acidic environment with precipitated by NaOH. It was later filtered via Whitman No. 1 filter paper. Protein content was calculated and expressed as a percentage of the sample weight (Makkar *et al*., 2008). Determination of molecular weight of protein by sodium dodecyl sulphate polyacrylamid gel electrophoresis of the faba bean protein: SDS-PAGE was performed according to the method of Laemmli (1970) in order to determine the molecular weight of partially purified protein. On average one SDS molecule binds for every two amino acid residues. SDS confers a negative charge to the polypeptide in proportion to its length, *i.e*., the denatured polypeptide becomes rods of negatively charged clouds with equal charge or charge densities per unit length. Samples to be run on SDS-PAGE are first boiled in sample buffer containing β-mercaptoethanol and SDS. The mercaptoethanol reduces any disulfide bridge present that is holding together the protein tertiary structure, and the SDS binds strongly, and denatures the protein. In denaturing SDS-PAGE separation, therefore migration was determined not by intrinsic electrical charge of the polypeptide but also by molecular weight. SDS-PAGE gel electrophoresis was performed on resolving and stacking gel at 12.5% and 4% concentrations of acrylamide: bis-acrylamide respectively, 6µl of the Laemmli dye or sample buffer added to 12 µl of partially purified protein, heated for 5 minutes at 95°C in a water bath and 9 µl of each mixture was injected to the stacking gel. The electrophoresis unit was filled with the running buffer and the electrophoresis was carried out at Table (3).

Table (3): Proteins used in the SDS-PAGE (markers): molecular weight and source*.

Protein	Molecular weight	Source
Thyroglobin	669.00	Hog thyroid
Ferritin	440.00	Hog thyroid
Catalase	232.00	Horse spleen
Lactat dehydrogenase	140.00	Beef heart
Phosphorylase-b	94.00	Rabbit muscle
Albumin	67.00	Bovine serum
Ovalbumin	43.00	Egg white
Carbonic anhydrase	30.00	Bovine erythocty
Trypsin inhibitor	20.10	Soybean
α-Lactalbumin	14.40	Bovine milk

*Obtained from Phamacia Fine Chemicals, Box 175 S-75104 uppsala 1, Sweden.

3. Results and Discussion

3.1 Chemical composition of faba bean seeds

The chemical composition of the fifteen faba bean is shown in Table (4) and Figure (1). Data indicated that the chemical composition of faba bean seeds varied significantly in all tested varieties and genotypes. The obtained results showed that the highest carbohydrate content was in Hybrid 23 (58.15%). While the lowest carbohydrate content in Missr 1 (51.11%), The average carbohydrate content was the highest and lowest in Hybrid 21 (54.44%). While the highest content of protein was in Giza 40 (30.68%), and the lowest protein content in Giza 716 (24.60%). The highest fiber content was in Giza 843 (4.87%) and the lowest fiber content was in Noubariaa 3 (1.85%). The highest and lowest Fat content was in Sakha 1 (2.61%), Sakha 4 (1.54%), respectively. The highest ash content was in Giza 716 (4.16%), and the lowest ash content was in Giza 40 (1.38%). The highest and lowest moisture content was in Noubariaa 1 (10.57%), Sakha 1 (9.07%), respectively. Similar studies were carried out by Bhatty and Christison (1984) which found that the chemical composition of faba bean protein (N × 6.25) were 32.2, ash 5.2, fiber 0.1 and starch 43.8.%. Carbonaro *et al*. (2001) indicated that the chemical composition (g/100 g dry weight) faba bean were protein, lipid, sugars, starch, total fiber and ash (27.3, 2.0, 5.5, 31.5, 26.2 and 4.2%, respectively). Musallam *et al*. (2004) reported the chemical composition of faba bean seeds as protein (27.06%), fat (1.90%), fiber (8.91%), carbohydrate (58.5%) and ash (3.62%). Hossain and Mortuza (2006) found that the chemical composition of Kalimatar (a local strain of faba bean) were protein (27.67%), fat (3.12%), fiber (2.48%), ash (5.67%), total sugar (4.97%) and starch (54%). Mortuza *et al*., (2009) found that the chemical composition of faba bean were crude protein (30.57±0.32%), crude fat (3.22±0.12%), crude fiber (2.73± 0.12%), ash (3.61±0.11%) and carbohydrate (59.87%). Elmanzlawy and El-Marsafawy (2013) reported that the chemical components of some genotypes of faba bean seeds were as follow: Genotype 1715 (protein (30.8%), carbohydrate (59%) and oil (5.1%)), Genotype 1716 (protein (30.6%), carbohydrate (59%) and oil (4.4%)), Genotype 1717 (protein (36.2%), carbohydrate (52.8%) and oil (4.7%)), Genotype 1718 (protein (30.9%), carbohydrate (60%) and oil (4.8%)), Genotype 1721 (protein (36.7%), carbohydrate (52%) and oil (4.8%)) and Genotype 1722 (protein (36.7%), carbohydrate (53%) and oil (3.3%)). Velasquez-Barreto *et al.* (2019) found that the chemical composition of raw materials of faba beans seeds were: moisture (7.73±0.47%), protein (32.46±1.12%), fat (2.13±0.65%), carbohydrates (55.12±2.36%) and ash (2.56±0.65%). Abdel-Aleem *et al*. (2019) studied the effect of soaking and cooking

on nutritional and quality properties of faba bean (*Vicia faba* L., Giza 843) and found that total protein content (%) and total carbohydrates (%) in raw bean were 29.13±0.06, 60.27±1.07%, respectively. Vogelsang-O'Dwyer *et al*. (2020) studied the chemical composition of faba bean protein-rich flour, and their results were moisture (12.2 and 6.11), protein (64.1 and 90.1), fat (2.43 and 4.36), ash (4.8 and 5.2), total carbohydrate (28.7 and 0.34) and starch (7.55±0.235 and 2.48±0.048 (g/100 g), respectively). Martineau-Cote *et al*. (2022) reported the chemical composition of faba bean as proteins (27.6%), total carbohydrate (66.0%), ash (3.4%), fat (1.4%) and total dietary fiber (12.9%).

Table (4): Seeds chemical composition percentages of tested faba bean varieties and genotypes.

Samples	Fat	Moisture	Protein	Ash	Fiber	Total carbohydrates
Giza 716	2.51	9.46	24.60	4.16	4.77	52.50
Giza 843	2.61	9.81	25.50	3.57	4.87	53.94
hybrid 24	2.09	10.33	28.25	1.81	2.08	55.44
hybrid 23	2.07	9.96	25.82	1.94	2.06	58.15
hybrid 22	2.09	10.52	27.51	1.61	2.09	56.19
hybrid 21	2.15	10.50	29.11	1.86	1.94	54.44
Noubariaa3	1.96	10.18	26.18	2.04	1.85	57.79
Wady1	2.28	9.79	29.23	3.99	4.30	52.36
Sakha 1	2.70	9.07	25.25	3.55	3.92	55.51
T. W	2.36	10.02	27.93	3.91	3.60	51.18
Giza 3	2.24	10.52	27.59	1.46	2.07	56.12
Noubariaa1	2.26	10.57	28.72	1.59	2.21	54.65
Missr 1	2.48	10.18	29.80	3.62	2.81	51.11
Sakha 4	1.54	10.01	28.63	2.98	2.09	53.26
Giza 40	2.33	10.30	30.68	1.38	2.28	53.12

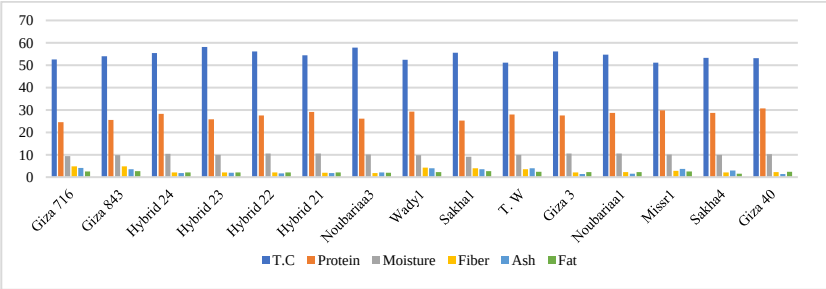

Figure (1): The chemical composition of the fifteen faba bean varieties and genotypes.

3.2 Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS–PAGE) of soluble proteins in seeds

The molecular weight (MW) of the protein was determined with the help of relative position of a specific molecular marker on SDS-PAGE, analysis of gel revealed that Giza 3, Giza 40, Sakha 4, Noubariaa 1 and T.W were resolved into

8 bands, while Giza 716, Giza 843, hybrid 22 and Missr 1 were resolved into 9 bands, while Hybrid 24, Hybrid 23, Wady 1, and Sakha1 were resolved into 10 bands. Also, hybrid 21 and Noubariaa3 were resolved into 11 bands. The molecular weight of protein subunits ranged between 15 and 352.5 kDa. As obvious form Figure (2A) and Table (5A) the SDS-PAGE patterns of total proteins revealed that protein subunits were 9 bands molecular weights of these subunits ranged from 198.33 to 15.25. These protein subunits are 198.33, 135.00, 96.20, 81.69, 63.00, 46.62, 33.04, 20.25 and 15.25 kDa. The percentage of the presence of these molecular weights in Giza 716, respectively 9.62, 8.54, 3.85, 0.17, 9.93, 0.14, 1.18, 49.05, 17.53%. While the electrophoretic analysis showed the molecular weights in Giza 843 ranged from 181.67 to 15.44 MW. The proportion of proteins with low molecular weights was high and was as follows: 17.95 MW (45.31%), 15.44 MW (23.81%). While the electrophoretic analysis showed the molecular weights in Hybrid 24 ranged from 160.00 to 15.64. The proportion of proteins with low molecular weights was high and was as follows: 17.85 MW (34.13%), 15.64 MW (41.68%), the molecular weights in Hybrid 23 of these subunits ranged from 306.67 to 15.54 kDa, and 18.53% and 9.86%, respectively.

Table (5A): SDS–PAGE patterns of soluble proteins extracted from some faba bean cultivars.

Lanes	Marker	Giza 716		Giza 843		Hybrid 24		Hybrid 23		Hybrid 22	
Rows	(MW)	MW	%	MW	%	MW	%	MW	%	MW	%
r1								306.67	18.53		
r2	165.00	198.33	9.62	181.67	9.84	160.00	6.10	155.00	10.77	160.00	11.69
r3	125.00	135.00	8.54	125.00	8.97	125.00	6.48			112.20	7.35
r4	93.00	96.20	3.85	91.39	4.56	93.00	2.55	102.60	4.58	89.77	5.96
r5		81.69	0.17			84.92	2.01	86.54	3.57		
r6	72.00			76.85	4.35	72.00	2.21	71.25	0.02	73.62	0.25
r7	60.75	63.00	9.93								
r8	57.00			57.75	2.25	58.50	0.01	59.25	2.84	55.85	6.61
r9	42.00	46.65	0.14	43.15	0.07	42.58	0.06	44.31	0.03	42.00	6.69
r10											
r11		33.04	1.18								
r12	31.00			30.22	0.85	30.22	4.76	30.42	7.09		
r13										28.28	0.93
r14	24.00										
r15		20.25	49.05								
r16	18.00			17.95	45.31	17.85	34.13	17.80	42.71		
r17										17.46	46.13
r18						15.64	41.68				
r19		15.25	17.53	15.44	23.81			15.54	9.86	15.34	14.39
r20	15.00										
Sum	10	9		9		10		10		9	

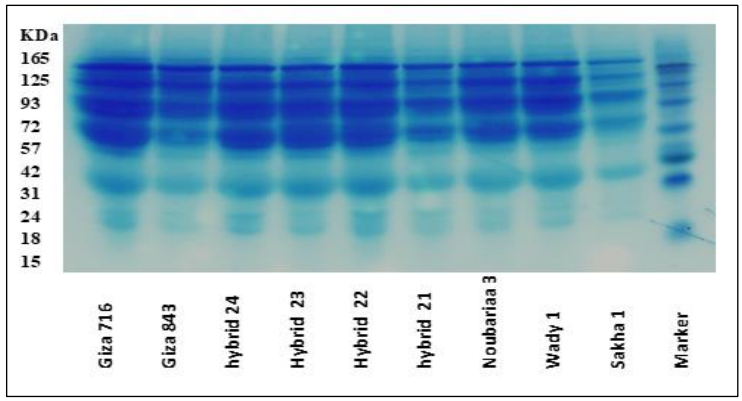

Figure (2A): SDS–PAGE profiles of soluble proteins extracted from some faba bean cultivars.

The molecular weights in hybrid 22 of these subunits ranged from 160.00 to 15.34 kDa, and 11.69% and 14.39%, respectively. As obvious from Figure (2) and Table (5B), the electrophoretic analysis showed the molecular weights in Hybrid 21 ranged from 150.00 to 14.80. The proportion of proteins with low molecular weights was high and was as follows: 17.26 MW (2.48%), 15.74 MW (39.95%), 14.80 MW (5.80%), also the electrophoretic analysis showed the molecular weights in Noubariaa 3 ranged from 140.00 to 14.85.

Table (5B): SDS–PAGE patterns of soluble proteins extracted from some faba bean cultivars.

Lanes	Marker	Hybrid 21		Noubariaa 3		Wady 1		Sakha 1	
Rows	(MW)	MW	%	MW	%	MW	%	MW	%
r1									
r2	165.00	150.00	7.16			150.00	4.29	160.00	9.54
r3	125.00	112.20	7.72	140.00	6.94	115.40	5.85	112.20	5.11
r4	93.00			109.00	8.29			89.77	3.14
r5		83.31	3.00	81.69	2.94	80.08	1.21		
r6	72.00	72.00	0.26					73.62	0.13
r7	60.75			68.25	2.90	68.25	1.05		
r8	57.00	55.27	1.95	54.69	2.18	55.85	1.09	55.85	1.68
r9	42.00								
r10		39.96	0.05	38.74	0.14	40.37	2.28	39.56	0.55
r11									
r12	31.00								
r13		28.86	2.82	28.28	4.34	29.06	0.70	28.67	4.40
r14	24.00	24.39	28.82	23.25	33.36	24.39	25.72	24.19	31.63
r15									
r16	18.00					17.66	26.69		
r17		17.26	2.48	17.31	1.84			17.26	4.65
r18		15.74	39.95	15.64	32.80			15.64	39.17
r19						15.49	31.11		
r20	15.00	14.80	5.80	14.85	4.27				
sum	10	11		11		10		10	

As obvious form Table (5C) and Figure (2B). The electrophoretic analysis showed the molecular weights in T.W ranged from 273.33 to 15.29. While, the electrophoretic analysis showed the molecular weights in Giza 3 ranged from 352.50 to 15.68 MW, also the electrophoretic analysis showed the molecular weights in Noubariaa1 ranged from 352.50 to 15.58 MW. The electrophoretic analysis showed the molecular weights in Missr 1 ranged from 335.83 to 15.29 MW. The proportion of proteins with low molecular weights was high as follows: 17.32 MW (13.04%), 15.29 MW (15.23%), the molecular weights in Sakha 4 of these subunits ranged from 327.50 to 15.10 kDa, and 1.13% and 16.60 %, respectively. The molecular weights in Giza 40 of these subunits ranged from 327.50 to 15.19 kDa, and 0.48% and 18.59 %, respectively. Similar studies were carried out by Hendawey and Younes (2013), revealed that Sakha 2 and Sakha 3 were resolved into 30 bands, while Giza 843, Giza 3, Noubariaa 1, and Missr 1 were resolved into 31 bands. Also, Sakha 4 was resolved into 32 bands. The molecular weight of protein subunits ranged from 14 and 95 kDa. The more intensive bands are presented at molecular mass were 20, 41, and 43 kDa.

Table (5C): SDS–PAGE patterns of soluble proteins extracted from some faba bean cultivars.

Lanes	Marker	T.W.		Giza 3		Noubariaa 1		Missr 1		Sakha 4		Giza 40	
Rows	(MW)	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%
r1				352.50	1.38	352.50	2.04	335.83	0.88	327.50	1.13	327.50	0.48
r2		273.33	5.483	285.83	6.26					265.00	1.47		
r3	240.00			227.50	3.27	240.00	8.28	252.50	5.23			240.00	2.81
r4								190.00	2.88				
r5	165.00	159.67	5.72	159.67	7.78					169.20	2.81	162.30	2.99
r6						143.67	7.79	151.67	7.42	141.00	4.320	135.67	7.28
r7	125.00	110.23	14.82										
r8	93.00					95.46	4.15	89.85	5.33				
r9				87.75	18.10					80.40	30.21		
r10	72.00	78.30	16.84			75.15	11.10	76.20	21.86			77.25	25.47
r11	60.75	65.44	21.89										
r12	42.00	42.00	21.81	41.08	25.71	40.78	32.64	40.17	28.14	40.47	32.11	41.69	30.27
r13	31.00												
r14	24.00												
r15	18.00	18.25	12.10	18.00	17.00					17.71	11.35		
r16						17.32	15.44	17.32	13.04			17.13	12.11
r17	15.00	15.29	1.43	15.68	20.50	15.58	18.58	15.29	15.23	15.10	16.60	15.19	18.59
r18													
r19													
r20													
Sum	11	8		8		8		9		8		8	

In this regard, a band of molecular weight 95 kDa is not presented in the samples of Giza 843, Giza 3, Sakha 2, and Sakha 3. Also, the band of molecular weight 52 kDa was disappeared in the sample of Nubaria 1, Missr 1, Sakha 2,

and Sakha 3. Regarding band intensity, it was increased at molecular masses 52 and 61 kDa for genotype Giza 843 as compared with the other faba bean cultivars. The same trend has been noticed at the polypeptide 57 kDa for genotype Giza 843 followed by genotype Giza 3 and Sakha 4. Also, the increase in band intensity was at molecular weight 64 kDa for Sakha 4, Nubariaa1, Missr1, and Sakha 2 compared to the other cultivars. Also, band of molecular weight 59 kDa for Giza 843 took the same trend followed by Giza 3, Sakha 4, and Sakha 3. In this regard, the band intensity for Giza 843, Sakha 4, Nubariaa 1, Missr 1, Sakha 2, and Sakha 3 at molecular weight 54 kDa was increased as compared with the other genotype. In addition, there was an increase in band intensity for Giza 843, Giza 3, Sakha 4, Noubariaa1, Missr1, and Sakha 2 at 49 kDa as compared with the other genotype.

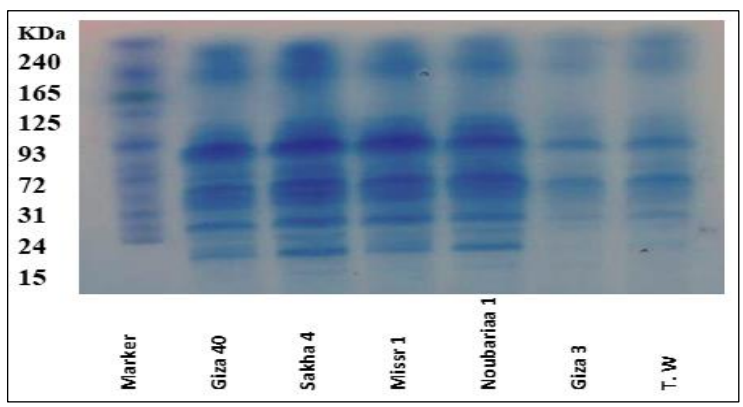

Figure (2B): SDS–PAGE profiles of soluble proteins extracted from some faba bean cultivars.

In this regard, a band of molecular weight 95 kDa is not presented in the samples of Giza 843, Giza 3, Sakha 2, and Sakha 3. Also, the band of molecular weight 52 kDa was disappeared in the sample of Nubaria 1, Missr 1, Sakha 2, and Sakha 3. Regarding band intensity, it was increased at molecular masses 52 and 61 kDa for genotype Giza 843 as compared with the other faba bean cultivars. The same trend has been noticed at the polypeptide 57 kDa for genotype Giza 843 followed by genotype Giza 3 and Sakha 4. Also, the increase in band intensity was at molecular weight 64 kDa for Sakha 4, Nubariaa1, Missr1, and Sakha 2 compared to the other cultivars. Also, band of molecular weight 59 kDa for Giza 843 took the same trend followed by Giza 3, Sakha 4, and Sakha 3. In this regard, the band intensity for Giza 843, Sakha 4, Nubariaa 1, Missr 1, Sakha 2, and Sakha 3 at molecular weight 54 kDa was increased as

compared with the other genotype. In addition, there was an increase in band intensity for Giza 843, Giza 3, Sakha 4, Noubariaa1, Missr1, and Sakha 2 at 49 kDa as compared with the other genotype.

4. Conclusion

Faba beans are used as a rich source of protein, so this study recommends the use of Hybrid 21 and Nubariaa 3 due to the high percentage of proteins as well as the increase in the number of proteins (bands) in the two varieties compared to the other varieties under study and also the high percentage of low molecular weights and this indicates that these varieties are resistant to insects when stored and for these reasons mentioned previously It is preferable to expand the cultivation of the two cultivars Hybrid 21 and Nubariaa 3.

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