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Influence of Potassium Sulfate on Faba Bean Yield and Quality

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Abstract: Faba bean cv. (Nubaria 1) was grown during the two consecutive seasons (2007/08 and 2008/09) in calcareous soil at Nubaria Research Station. Four potassium sulfate application (48% k_2So_4) at the rate of 50 kg./fed. at different plant stages were used. This investigation was conducted to study the effect of potassium sulfate fertilizer on growth, yield and improve the nutrition value of faba bean under calcareous soil at Nubaria Research Station. Addition of k_2So_4 at the beginning of flowering stage significantly increased seed yield and its components. Potassium sulfate gave the highest level of protein content and lowest level of total carbohydrates when added after 3-4 weeks of planting. Adding So_4 twice (after 3-4 weeks of sowing + at the beginning of flowering stage) had the highest ash content and the lowest fiber content. Potassium sulfate fertilizer caused slim increase in lysine, throenine, cyctine and methionine. Also potassium sulfate fertilizer caused increment in glycine amino acid and arginine. It could observed increment in potassium, phosphorus and iron content compared with control. On the other hand k_2So_4 decreased molybdenum content and there were some reduction in total vicine content in green seeds. Potassium sulfate fertilizer improved faba bean cookability.

Key words: faba bean, sulfate fertilizer, yield, amino acid, favism, cookability.

INTRODUCTION

Faba bean (Vicia faba L.) is an important legume crop in Egypt and many parts of the world. Its seeds exhibit high levels of protein (28–36 % of seed dry matter). And it is popular breakfast food and also used as vegetable green or fresh canned. Also, it is an important crop for soil improvement and used as break crop in cereal rotation to keep the soil fertile and productive through nitrogen fixation.

Sulfur and organic manure are frequently considered the most important amendments for soil reclamation and improvement, especially for calcareous soils. Adding sulfur or other soil amendments may be considered an effective method to lower such high pH values in the soil and, hence, improving the availability and uptake of phosphorus micronutrients by the plants (Yousry *et. al.,* 1984; Dawood *et. al.,* 1985; Dawood, 1989 and Abdel-Samad *et. al.,* 1990). Moss *et. al.,* (1981) reported that sulfur plays an important role in protein and chlorophyll biosynthesis and in the activities of certain enzymes. El-Safty (1998) reported that the addition of sulfur to the calcareous soil at any rate caused a pronounced increase in Washington Orange leaves content of S, N, Zn, Mn and Fe.

Grain legumes are plant species belonging to the family Fabaceae are cultivated for their mature seeds or immature green pods. Grain legumes are good sources of protein (average protein content of dry seed being 20 - 26 %). They are often considered as natural supplement to the cereal grains, since, although they are usually deficient in the sulphur amino acids methionine and cystine, they contain adequate amounts of Lysine. Their chemical composition is subjected to fluctuation depending on various factors like cultivars, maturity stage, environment (mostly weather condition), agrotechinics and others (Korus, *et. al.,* 2006). Increasing the amount of methionine in the amino acid profile of legumes would enhance its value for producers and consumers. Methionine contain S, and so its production is necessarily linked to sulfur metabolism within the legumes plant. Sulfur is taken up from the soil in the form of sulfate. During vegetative growth developing leaves to be the predominate site of sulfate reduction and incorporation of reduced S into amino acids. During reproductive growth, developing pods and seeds seem to be the predominate location of sulfate reduction. Sulfate reduction and methionine synthesis of storage proteins within the developing seed is sensitive to the

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amount of methionine present such that provision of extra methionine blocks synthesis of poor quality storage proteins. Sulfur deficiency on the other hand dramatically enhances accrual of poor quality seed storage proteins. It appears that the plant manufactures higher quality storage proteins as methionine is present in adequate quantities relative to the non-S-amino acids. Accumulation of poor-quality seed storage proteins thus appears to be a function, at least to some degree, of rate of methionine synthesis within the seed (Linda and Micheil, 2007). Plant utilizing sulfur for the synthesis of essential amino acid and proteins. Sulfur for plant nutrition can be applied directly as elemental sulfur, ammonium sulfate, potassium sulfate or superphosphates. Decreases in atmospherically deposited sulfur from air pollution in recent years may increase the need for sulfur fertilization of crops in some locations (SOFIA, 2007).

The major problem of faba bean breeding is further improvement of the yield and quality of seed and green matter. This can be achieved by increasing content of nutrients along with low anti-nutritional factors (e.g. vicine and convicine, the causative of the Favism). (Abdalla, *et. al.*, 2009) reported that spraying faba bean plants with micronutrients showed to be necessary to improve faba bean performance and yield.

The faba bean is known to contain the glucosides, vicine and convicine, the aglycone components of which (divicine and isouranil respectively) have been shown to cause a rapid oxidation of G S H in Glucose 6-Phosphate Dehydrogenase (G6PD) deficient erythrocytes but not in normal cells.

Since the favism is related to the X chromosome, males are more severely affect than females which are simply transmitting or suffering in a more mild manner.

Glucose 6-Phosphate Dehydrogenase (G6PD) deficiency is an inherited disease with a high prevalence in Africa, Southern, Europe, the Middle East, and South East Asia, and in descendants of migrants from these areas. G6PD is involved in the production of NADPH, which maintains glutathione, and consequently other proteins, in the reduced state when erythrocytes are subjected to an oxidant stress. Reduced concentrations of G6PD render red cells susceptible to haemolysis under conditions that occur when faba beans are ingested (Favism), or during infection (Lim and Acdalla, 2005).

The aim of this work is to study the effect of potassium sulfate fertilizer on growth, yield and improve the nutrition value of faba bean under calcareous soil at Nubaria Research Station.

MATERIALS AND METHODS

This investigation was carried out during the two consecutive seasons (2007 / 08 and 2008 / 09) in calcareous soil at Nubaria Research Station to study the effect of potassium sulphate application with recommended dose (50 kg k_2So_4 / fed.) on yield and its components of faba bean cv. Nubaria 1 (which belongs to the major type and highly resistant faba bean cultivar for foliar diseases and which recommended for Nubaria region) along with some physical and chemical traits. Regular analysis of variance of RCBD on plot mean was conducted. Each plot consisted of four ridges. Each ridge was 3 m long, 60 cm apart and 20 cm between hills. Recommended cultural practices for growing faba bean were followed. The main physical and chemical characteristics of the soil of the experimental site were determined according to the method described by Rage *et. al.,* (1987) and presented in Table 1.

Potassium sulphate fertilizer (48% k_2So_4) at the rate of 50 kg./fed. was used as soil application at different stages of plant.

1. Control (without k_2So_4).
2. Adding potassium sulphate, 3 – 4 weeks after sowing.
3. Adding potassium sulphate at the beginning of flowering.
4. Adding potassium sulphate twice (after 3 – 4 weeks of sowing and beginning of flowering stage).

After 70 days from sowing, a vegetative sample consisted of ten plants were taken randomly from each plot to determine chemical composition, total glycosides and amino acid content of green faba bean seeds. Also, at harvest, ten plants were taken randomly from each plot to determine the agronomic characters chemical, physical and cooking properties of the dry seeds.

1. Plant height (cm).
2. Number of branches / plant.
3. Number of pods / plant.
4. Number of seeds / plant.
5. Seed yield / plant (g).
6. 100 - seed weight (g).
7. Seed yield (ardab / Fed.).

Table 1: The main chemical and physical characteristics of the experimental soil at Nubaria Agriculture Research Station.

Characters	Value
Soil pH*	8.2
E.C.ds m^{-1} **	2.44
Water soluble cations meq / l:	
Ca^{2+}	11.45
Mg^{2+}	8.19
K^{+}	1.19
Na^{+}	3.52
Water soluble anions meq / l:	
CO_3^{2-}	0.0
HCO_3^{-}	5.0
SO_4^{2-}	6.3
Cr	13.0
$CaCO_3$%	27.4
Organic matter %	0.4
K_2SO_4-extrs field N, mg / g soil	20.7
$NaHCO_3$-ext. P, mg / g soil	18.8
NH_4-OAc extract-K mg kg^{-1}	116.0
Mechanical analysis:	
Sand %	64.6
Silt %	12.5
Clay %	22.9
Soil texture	Sandy clay loam

* measured in 1: 2.5 soil suspension.
** measured in water extracted of saturated soil paste.

Determination Of Proximate Chemical Compositions:

Approximate chemical composition with moisture content, protein content, ether extract, ash content and crude fiber were determined according to the method described in A.O.A.C., (2000). Total carbohydrates were calculated by difference.

Minerals: potassium (k), magnesium (Mg), and Iron (Fe) contents were determined after ashing by using Perkin-Elmer 2365 Atomic Absorption spectrophotometer (Germany) as described in the A.O.A.C. (2002).

Phosphorus content was determined by spectrophotometer at 650 nm according to the method described in A.O.A.C., (2000).

Molepdinum (Mo) content was determined according to the method described in A.O.A.C., (2002).

Determination Of Amino Acid:

Amino acids were determined according to A.O.A.C., (2006).

Determination Of Total Vicine:

Total glycosides expressed as total vicine content: Total vicine content was carried out by the method of Abdallah *et al.*, (1988). One gram of finely prepared dried seeds was homogenized in a blender with 100 ml. of freshly prepared solution of 4 % meta phosphoric acid for 5 min., centrifuged for 30 min. at 2000 r.p.m. and the supernatant was filtered through a Whatman No. 4 filter paper.

Exactly 1 ml of the filtrate was diluted to 10 ml. with distilled water and the absorbance read at 273 nm using ultra violet spectrophotometer model Beckman DU-40.

The total glycosides expressed as total vicine content was calculated according to the following equation:

$A = b\ c$ Beer's Low

Where:
A = absorbance at 273 nm
b = thickness of cuvette
c = molar concentration

The total glycosides expressed as vicine and convicine was calculated as total vicine in milligram per gram dry sample according to the following equation:

$$\text{Total vicine (mg/g)} = \frac{C \times 322}{W}$$

Where:
322 = molecular weight of vicine
W = weight of dry sample in g.

Technological Characters:

Seeds were cooked 12 hr. at 100°C. The following measurement were determined in cooked seeds according to the method of Fahmy *et al.*, (1996).

Imbibed water: The cooked seeds were drained and weighed, percentage of imbibed water calculated as follows:

$$\% \text{ imbibed water} = \frac{wt.of\ cooked\ seeds - Initial\ wt.seeds \times 100}{Initial\ wt.of\ seeds}$$

Water soluble solids: The solution containing soluble material was poured into a porcelain pot placed in an oven at 60°C until all the water was evaporated. The pot was weighed and water soluble solids calculated as follows:

$$\% \text{ water soluble solids} = \frac{wt.of\ pot\ after\ drying - wt.of\ empty\ pot \times 100}{Initial\ wt.of\ seeds}$$

Stewing % (cookability): The ability of cooked seeds was measured by means of using the normal press of fingers and comparing between the cooked seeds for their hardness.

Statistical analysis: The data subjected to an analysis of variance using the Statistical Analysis System (SAS, 1996). Differences among means within the samples were tested using Duncan's multiple – range test at the 5% probability level.

RESULTS AND DISCUSSION

The effect of potassium sulfate fertilization at different stages of plant growth are presented in Table 2. Results show that the addition of k_2So_4 at the beginning of flowering stage (treatment 3) significant increased all studied characters and recorded the highest stimulus of plant height (115.0 cm), number of branches / plant (6.35), number of pods / plant (19.95), number of seeds / plant (81.42), seed yield / plant (96.805), 100-seed weight (118.705) and seed yield / Feddan (12.79 ardab) followed by application of k_2So_4 twice (treatment 4) with a mean of 110.0, 5.9, 71.35, 83.05, 115.58 and 12.75 for the above mentioned characters in the same order. Such findings can be ascribed to that potassium is one of essential elements in plant nutrition which enhanced plant growth and area common is sufficient supply in the soil affects plant growth.

These results are in full agreement with those obtained by Fatma *et al.*, (2001) who reported that the addition of 50 kg k_2So_4 / fed. to mung bean plants significantly increased stem length, number of branches/plant, number of pods/plant, 100-seed weight, seed yield/plant and seed yield/Fed. Singh and Kumari (1990) pointed out that mung bean yields increased from 345 to 623 kg/ha with increasing k_2So_4 up to 30 kg/ha. Saxena *et al.*, (1996) reported that the application of k_2So_4 at the rate of 20 kg/ha to green gram plants affected significantly seed yield and physiological parameters.

Chemical Composition:

Table (3) showed the effect of potassium sulfate fertilizer on chemical composition of green faba bean seeds. Data indicated that treatment (2) had the highest level of protein (35.13%) followed by treatment (3) (34.13 %) respectively. Concerning to ash content treatment (4) had the highest level (5.39%). Fiber decreased significantly and treatment (4) had the lowest content (6.30%), at the same time, the same treatment had the highest fat content (1.88%). Treatment (3) had the highest carbohydrate content (55.42%), while treatment (2) seemed to have the lowest value (51.37).

Table (4) showed the effect of potassium sulfate fertilizer on chemical composition of dry faba bean seeds. Data indicated that treatment (2) had the highest estimation of protein (28.20%) and recorded the lowest level of total carbohydrate. Vic versa treatment (3) recorded the highest level of carbohydrate (64.24%) and had the

Table 2: Mean performance of some evaluated characters under soil potassium sulfate application during 2007/08 and 2008/09 seasons at Nubaria Research Station.

Treatment	Plant height 07/2008	No of branches 07/2008	No. of pods 07/2008	No. of seeds/plant 07/2008	Seed yield/plant 07/2008	100-seed weight 07/2008	Yield (Ardab/Fed.) 07/2008	08/2009	control
Control (1) (without k_2So_4)	102.5	5.80	12.55	49.85	56.40	109.18	10.33	11.11	10.72
Adding k_2So_4 after 3-4 weeks of sowing (2)	105.0	5.60	13.25	52.40	61.70	117.03	10.82	11.67	11.24
Adding k_2So_4 at the beginning flowering stage (3)	115.0	6.35	19.95	81.42	96.80	118.70	12.88	12.60	12.74
Treatment 2 + 3 adding k_2So_4 twice (4)	110.0	5.95	18.05	71.35	83.05	115.58	11.80	12.70	12.25
C.V.	8.75	9.02	11.98	14.10	16.33	2.97	8.57	6.97	7.77
L.S.D	NS	NS	3.06	14.38	19.46	5.47	1.57	NS	

It can be concluded that the maximum yield and yield components were gained from treated faba bean cv. Nubarial with 50 kg k_2So_4/fed. at flowering stage compared with control and other treatments.

Table 3: Chemical composition (%) dry basis of green faba bean seeds as affected by potassium sulfate treatments.

Treatment*	Protein	Ash	Fiber	Fat	carbohydrate
Control (1)	30.46	4.51	10.55	1.35	53.16
Treat. (2)	35.13	3.94	8.64	0.94	51.37
Treat. (3)	29.62	4.63	9.03	1.30	55.42
Treat. (4)	33.45	5.39	6.30	1.88	52.99
L.S.D	0.58	0.58	0.55	0.13	0.62

* Treatment: 1 = Adding potassium sulfate after 3-4 weeks of planting, 2 = Adding potassium sulfate at beginning of flowering stage, 3 = Adding potassium sulfate after 3-4 weeks of planting and at beginning of flowering stage.

Table 4: Chemical composition (%) dry basis of dry faba bean seeds as affected by potassium sulfate treatments.

Treatment	Protein	Ash	Fiber	Fat	carbohydrate
Control (1)	26.58	3.28	5.64	2.03	62.49
Treat. (2)	28.20	3.24	6.54	1.68	60.34
Treat. (3)	23.55	3.52	6.88	1.81	64.24
Treat. (4)	27.68	3.58	4.75	2.21	61.78
L.S.D	1.60	0.05	0.91	0.28	1.03

lowest level of protein (23.55%). Treatment (4) had the highest ash content (3.58%) and oil (2.21%), at the same time had the lowest level of fiber (4.75%), while treatment (3) had the highest fiber content (6.88%).

Amino Acid Content:

The nutritional value of legumes protein is judged by its protein content, the digestibility of protein and the number and amount of essential amino acid.

The amino acid composition of faba bean as affected by potassium sulfate fertilizer presented in Tables (5) and (6).

Table (5) showed the amino acid composition of green faba bean seeds. The data indicated that faba bean rich in lysine. Potassium sulfate fertilizer caused slim increase in lysine for treatment (3) and (4) compared with control.

Concerning to sulfur amino acid, there were slight increase in threonine, cystine, and methionine, since treatment (2) had the highest value of cystein and methionine (0.30 and 0.28%) compared with control (0.19 and 0.18%) respectively. Tyrosine decreased by potassium sulfate treatment. From tables (5) and (6) it could be noticed that glutamic is the main component of non essential amino acid for both immatured (green) and matured (dry) seeds, since the level of this amino acid was 4.03 and 3.72 %, respectively. High content of glutamic means high drought tolerance. Proline also increased by potassium sulfate fertilizer in green faba bean seeds table (5).

Regarding to mature faba bean (dry) seeds Table (6) showed increase in lysine content, the highest value observed for treatment (2), the increasing percent was 62% compared with control. Limited changes were observed in cystene and methionine content.

Potassium sulfate caused increment in glycine amino acid and the highest value was in treatment (2) followed by treatment (4) and (3) (1.31, 1.07 and 0.98 %) respectively compared with control (0.88 %).

In the same table (6), it could be observed that arginine increased by potassium sulfate fertilizer and treatment (4) had the highest value compared with control, the increasing percent was 80.11%, 40.88, and 40.33%, for treatments (4), (3) and (2) respectively.

Table 5: Essential and nonessential amino acid content (%) in green feba bean seeds.

Amino acid	Treatment			
	Control (1)	(2)	(3)	(4)
Essential amino acid				
Lysine	1.42	1.04	1.50	1.58
Threonine	0.87	0.96	0.81	0.88
Cystine	0.19	0.30	0.27	0.28
Methaionine	0.18	0.28	0.22	0.26
Valine	1.44	1.40	1.22	1.34
Iso lucine	0.87	0.96	0.88	0.93
Leucine	1.68	1.63	1.64	1.65
Tyrosine	1.18	0.94	0.75	1.08
Phenyl alanine	0.92	0.95	0.95	0.95
Nonessential amino acid				
Serine	1.31	1.09	1.07	1.04
Proline	0.93	1.37	1.14	1.16
Glycine	0.92	1.00	0.96	0.98
Aspartic	2.60	3.79	2.95	3.33
Glutamic	4.03	4.06	3.96	4.05
Histadine	0.56	0.92	0.75	0.85
Arginine	2.14	2.54	2.24	2.35

Table 6: Essential and nonessential amino acids content (%) in mature (dry) faba bean seeds.

Amino acid	Treatment			
	Control (1)	(2)	(3)	(4)
Essential amino acid				
Lysine	1.28	1.91	1.52	1.62
Threonine	0.84	1.06	0.81	0.89
Cystine	0.27	0.31	0.27	0.28
Methaionine	0.14	0.19	0.15	0.16
Valine	0.85	1.06	0.84	0.91
Iso lucine	0.84	1.00	0.77	0.86
Leucine	1.73	2.15	1.71	1.91
Tyrosine	0.94	0.75	0.90	0.97
Phenyl alanine	1.04	1.37	1.04	1.06
Nonessential amino acid				
Serine	0.86	1.43	0.98	1.20
Proline	1.20	1.16	0.94	0.98
Glycine	0.88	1.31	0.98	1.07
Aspartic	2.55	3.09	2.53	2.79
Glutamic	3.70	4.79	3.60	4.06
Histadine	0.78	0.88	0.70	0.74
Arginine	1.81	2.54	2.55	3.26

(Hill-Cottingham and Purves, 1983) mentioned that during plant development there were marked differences in both the amount and composition of the free amino acid fraction in some organs. The concentration of aspargine increased sharply during pod-fill in both stems and pods and it is suggested that the form in which N is moved into the seeds for protein synthesis. Young seeds contained much free aspragine, glutamine and alanine but with the time the two latter constitutes were replaced by agrinine.

The inside of blood vessels are lined with a layer of single cells called the endothelium. Among other functions, the endothelium produces nitric oxide which serves to relax (vasodilate) the blood vessels so to facilitate the flow of blood. It is now generally accepted that many heart problems involve a dysfunction of antioxidants, estrogen, exercise, folic acid, and fish oils. Now researchers at the Stanford University School of Medicine report that supplementation with the amino acid L-arginine is highly effective in reversing endothelial dysfunction. It has been established that L-arginine is the precursor for endothelium-derived nitric oxide (EDNO). EDNO, in true, is a potent vasodilator and inhibits platelet aggregation and the adherence of circulating blood cells to blood vessel wall. L-arginine has been found useful in preventing and reversing atherosclerosis, in increasing coronary blood flow in heart disease patient, and in improving functional status of heart failure patients and have been found to lower pressure (Max Well and Cook, 1998 and Cathy, 2007).

Cathy, (2007) mentioned that L-arginine's possible activity in wound repair may be due to its role in the formation of L-proline, an important amino acid that is essential for the synthesis of collagen. Food sources of L-arginine include plant and animal proteins, such as dairly products, meat, poultry, fish and nuts. The ratio of L-arginine to lysine is also important. Plant protein have more L-arginine than animal sources of protein.

L-arginine is also essential for children with rare genetic disorders that impair the formation of L-arginine.

Minerals Content:

Table (7) showed some mineral content of dry seeds as affected by potassium sulfate treatments. Data showed that faba bean is considered a good source of minerals. Concerning to potassium content, it could observed increment in potassium content in all treatments. The highest value was 9965 mg/kg for treatment (4). Treatment (2) showed increase in phosphorus content (450 mg/kg) compared with control and the two other treatments. This means that treatment (2) is relatively high user of phosphorus. On the other hand faba bean is a good source of iron. Treatment (4) showed increase in iron content, since the increasing percentage was about 71 % compared with control.

Table 7: Mineral content of dry bean (mg / kg)

Treatment	K	P	Mg	Fe	Mo
Control (1)	9329	370	310.5	115.9	18.750
Treat. (2)	9908	450	205.0	113.2	9.327
Treat. (3)	9938	350	191.5	112.5	5.941
Treat. (4)	9965	360	224.3	199.3	9.110

Regarding to molepdinum level, the tabulated data showed that faba bean an excellent source of molebdenum. Potassium sulfate caused decrease in molebdenum content in all treatments.

Molebdinum has an important role in reducing the toxicity of So_2 from air pollution via sulfuric process by the enzymes. These enzymes require molebdinum for their reaction. (Donald *et. al.,* 1999).

Mengel and Simic, (2008) reported that, the potassium supply affected potassium and nitrate content of the exudation sap of sunflower plants. Both were lower in the treatment without potassium. The calcium and magnesium contents were not significantly influenced by the potassium treatment, whereas the phosphate content was higher in the treatment without potassium. At the beginning of the exudation period the potassium supply did not effect of amino acid in the exudates, but later the plants supplied with potassium showed higher content of amino acids in the exudation sap.

Total Glucosides:

Concerning total vicine content, the data in table (8) showed that green seeds had higher amount of total vicine than dry seeds. On the other hand, when the four potassium sulfate treatments were concerned, it was found that complete elimination of total vicine was failed to achieve in all tested samples as seen in the same table. The point which could be noticed, is that potassium sulfate caused some reduction in total vicine content in immature (green) seeds for treatment (3) and (2). The reduction percentage were 44.42 and 17% for both treatments, respectively.

Table 8: Effect of potassium sulfate treatments on total glycosides (total vicine) content (mg/g) immature (green) and mature (dry) as well as cooked dry faba bean seeds.

Treatment ------------------------------------- Sample	Control (1)	(2)	(3)	(4)	L.S.D.
Raw immature seeds (green)	32.565 [a]	26.935 [b]	18.04 [c]	32.54 [a]	1.898
Raw mature seeds (dry)	13.20 [a]	13.335 [a]	12.51 [a]	12.955 [a]	0.9732
Cooked dry seeds	13.28 [a]	13.00 [a]	13.10 [a]	13.45 [a]	0.91543

On other hand total vicine in cooked dry seeds had no change, this means vicine is heat stable.

Olsen and Anderson (2006), reported that total vicine content in isolated faba bean proteins ranged from 0.07 to 2%.

Sisini *et. al.,* (1981), determined total vicine (vicine + convicine) in different lines of vicia faba beans throught the biological cycle of the plant and found that as the seed matures the levels of total vicine decrease with seed maturation in all the lines examined.

Same observation carried out by Burbano *et. al.,* (1995), they mentioned that total vicine (vicine + convicine) content was highest in fresh green cotyledons and gradually declined until a constant level was reached when seed dry matter percentage was round 40%.

Vicine and convicine are thermostable products and removal or destruction of these causative agents by processing is difficult. Much breeding effort has been placed on these two types of antinutritional factors with success. (Duc, 1991).

Cooking Quality:

Effect of potassium sulfate on cooking quality, data in table (9) revealed that imbibed water increased non significantly, while total soluble solids increased significantly and treatment (3) had the highest value (15.77%), followed by treatment (4) (13.53%). Regarding to stewing percent, data revealed that stewing percent increased significantly as affected by potassium sulfate fertilizer and treatment (3) showed the highest stewing percent (100%), this means potassium sulfate improved faba bean stewing character.

Table 9: Effect of potassium sulfate treatments on cooking quality of bean dry seeds.

Treatment	Imbibed water (g)	Total soluble solids %	Stewing %
Control (1)	172.05	8.50	85
(2)	171.54	12.10	95
(3)	179.37	15.77	100
(4)	174.00	13.53	95
L.S.D	NS	2.48	8.16

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