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Follow-Up Of The Development Of Water-Soluble And Fat-Soluble Minerals And Vitamins For Germination And Non-Germination Sorghum Grains During Different Germination Periods

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Abstract

The study was conducted in the laboratories of the Department of Food Sciences, College of Agriculture, University of Basrah, Iraq, using sorghum kernels, cultivar Kafir, as a feed crop with economic feasibility that can be used. In the research study, sorghum grains were used with different germination periods (24, 72 and 96 hours) and their chemical composition was studied, where it was characterized by a high protein content at germination periods of 96 and 72 hours, due to the effect of the germination process on the protein content and the lack of moisture to reduce infection with fungi and microorganisms, and the low-fat content during germination periods is due to the different genetic composition of the cultivars, as well as to water absorption and enzyme activity in the endosperm and digestion of reserve materials, and as a result of the activity of the enzyme lipase, which breaks down fats into glycerides and fatty acids and the increase in fiber and carbohydrates during the germination period, and when studying the content of mineral elements, the results showed an increase in the proportions of mineral elements during the germination periods of 96 and 72 hours, with the superiority of iron, zinc and manganese during the germination period of 96 hours. While the device is not sensitive to the elements cobalt, chromium and nickel, which are caused by pollution by hydrocarbons emitted from oil sources, so sorghum is a rich source of nutritional and healthy minerals for the body and sorghum contains water-soluble and fat-soluble vitamins and its high content during the germination periods that were conducted on sorghum with the excelled of the vitamin B group, vitamin C and vitamin E, and through the results of high-performance liquid gas chromatography, the content of water- and fat-soluble vitamins was estimated, and the profiles showed the excelled of vitamins during the germination periods.

Keywords: High performance gas liquid chromatography, - B Complex - heavy elements, atomic absorption.

Introduction

Grains have an important and essential role in the lives of most peoples, especially in the developing countries of the third world. It provides the body with the basic needs of carbohydrates, proteins, fiber, vitamins and mineral elements, and the urgent need for them in the food of all societies due to its small size and low moisture (about 15%), which helps to facilitate its transportation and storage for a long period without being exposed to any damage. It is rich in nutrients, dry as it reaches 85% is dry matter, and protein is included in its composition with about 7-12%, lipids by 2-5% and carbohydrates 85% in the form of starchy materials. [32,43],[38].grain crops are classified within the Gramineae or Poaceae family which includes barley, wheat, millet, sorghum, yellow corn , oats and other crops [14,7]. its English name is Sorghum, and the scientific name is Sorghum bicolor (L.) Moench. It ranks fifth in terms of importance after wheat, rice, yellow corn and barley at the global level in terms of cultivated area and production. One of the advantages of white corn is that it enters the bread and pastry industry with 30% and 70% of wheat, Sorghum grains are also included as a supplement in the concentrated ration of poultry due to the high protein content in it, reaching 12%. Protein is one of the important components that reflects the quality of sorghum grains and the extent to which plants benefit from growth elements in increasing the chemical content of grains, especially as it is included in the preparation of concentrated rations as a food item for poultry[9,12,37] . As for the origin of corn, it is believed that it originated in eastern and central Africa, and the date of its cultivation by man is not exactly known. The prevailing belief is that it was known in Egypt at least (5) thousand years ago, and was known to the Assyrians since 700 BC [11]. Sorghum is one of the important field crops that are grown in most countries of the world except for northwestern Europe due to low temperatures. It is a food, feed and industrial crop and its importance has increased during the last thirty years. It is used to feed animals and humans after mixing it with 25-30% with wheat flour. It is also possible to obtain cooking oil from its grains, making alcohol, and producing starch and glucose. It contains a high percentage of protein, and its grains are a rich source of vitamin B group [35],[17][16] .There are several types of white corn, including Grain Sorghum bicolor, whose cultivars are characterized by the production of abundant grain yield, and their grains are large in size compared to other types, and their color is white or yellow. Sweet corn sorghum bicolor moench the plants are tall and contain sweet juice. The grains vary in color from red to brown or white. feed Sorghum includes Sudanese weed, which is characterized by its thin stems with a length of 100-150 cm. Branches and open branched clusters. Broomcorn is characterized by its thick stems, anxious leaves, and short cluster carrier. Sorghum that is grown for the purpose of seed production contains several types, including Kafir, local, Hegari, Milo, rescue and short winner [20] [16].The process of germination is an important stage in the life of a plant and it is defined as the emergence of the radical and plumule , as germination begins with the emergence and formation of young plants in a new environment when the appropriate conditions are available for them [22,28]. as it occurs in the process of germination. Germination is major chemical changes which decompose the nutrients stored in the seed into simpler compounds and the transfer of these materials from the endosperm to the embryo or from the cotyledons to the developing parts of the germinated seeds. The seeds germination helps the plant to resist the environmental stresses that may face the plant, and the importance of seed germination increases with the increase of environmental stresses. It is soaking the seeds with manufactured or natural solutions that enhance the strength of the seeds to withstand stress and also give a speed and a high and homogeneous germination rate [5,7]. grain with live embryos are among the traits that depend on determining the type of grain suitable for the manufacture of malt, as it shows that the decrease in grain germination leads to a decrease in the nitrogenous substances represented by amino acids formed during the germination stage, and the lack of enzymes for diastase represented by alpha-amylase and protease that are formed during the germination stages , The activity of enzymes can be increased by using growth regulators, including the hormone gibberellin, and the decrease in grains with live embryos negatively affects the viability of grains for making malt [25,31,6].The study of the absorption of radiation energy by atoms is a quantitative analytical method that means the absorption of light at a specific wavelength ג and fixed for one element by its free atoms. The amount of absorbed radiation increases at this wavelength by increasing the number of atoms of the element in the path of the radiation. Where the spectrum is related to the concentration, through it, we can know more than 60 components of one sample with a very high accuracy of up to 1 in a million. This method depends on converting the metallic substance into free atoms, that is, converting the substance to the atomic state and estimating the radiant energy absorbed by these atoms. Where the degree of absorption is proportional to the number of atoms present in the sample of the element to be determined is directly proportional to the concentration of this element. The amount of absorbed rays at this wavelength increases with the increase in the number of atoms of the wave element in the path of the rays. This technique is characterized by the possibility of identifying an element on a complex background without the need for separation processes now for each light source element of its own, as the aim of this study was to determine the mineral content in grains of seven hybrids of edible sorghum, It was bred and adapted to grow in the central USA and grown in the Mediterranean region of southern Italy. The seven crosses were analyzed for grain and mineral contents. Nutritionally, the content of total and minor essential elements and trace elements was examined. Elemental element analysis was performed by mass spectrometry [24].Vitamins are organic compounds necessary to enhance and regulate the body's processes necessary for growth, reproduction and maintaining health. Vitamins are divided according to their solubility into water-soluble vitamins, which are the B vitamins and fat-soluble vitamins (A.D.K.E) and each of these vitamins is important for the body, where vitamin A is an antioxidant and a source of vision, vitamin E is also an antioxidant, vitamin K is an anticoagulant, and vitamin D is important for the upgrading and maintenance of gland secretions in the body, while the importance of water-soluble vitamins, vitamin B1 (thymine) is important in glucose metabolism, while vitamin B2 (Riboflavin) is important in improving vision, maintaining skin and providing energy for the body, and vitamin B3 (niacin) is important in energy production, digestion, skin and nerve health,While the vitamin B6 group that includes pyridoxine, pyridoxal, and pyridoxamine which helps the body in protein metabolism and the formation of red cells and participates in the formation of insulin and hemoglobin, while vitamin B12 (cobalamin) has an importance in building the genetic material of the body (Al Taei, 2017). 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While the results of the analysis by atomic absorption of mineral elements showed that the three types of sorghum contain all the mineral elements that were analyzed .

1- working methods

1-1 Preparation of samples

The grain samples under study were cleaned of foreign matter, damaged and broken grains, and fine grains and impurities were removed from the sorghum crop.

1-2 Steeping

The method of [19].Narsih et al., (2012) was followed with some modification for the purpose of stabilizing the time required for moisture absorption for each of the cultivars under research, which was set at (45-55%) the time was fixed for the sorghum grains under study. dry weight in each basket,After that, the plastic baskets were placed in the soaking basin at varying times to reach the required humidity for the items under study, with water replaced every 6 hours to preserve the samples from fungal growth.

1-3 Germination

The method described in [3]. Abd Elmoneim et al., (2017) it was followed with some modification. The germination process of the studied grain types under study was carried out for different periods of time with the addition of water at the beginning of the first and second days to maintain the moisture content in the range (55-45%). As an amount of water was added to the amount of 100 ml on the second day and 50 ml on the fourth day.The germination period lasted 48-120-169 hours, depending on the type of cultivars used in the study, with the samples moistened from time to time to maintain their moisture and their germination in an integrated manner. The samples were kept in polyethylene bags in the freezer until the study was conducted on them.

2.1 Chemical tests

2-1-1 Moisture estimation

The moisture in the types of grains and malts was estimated according to the method mentioned in [1].(A.O.A.C.2008). Weighed 5 g of samples and placed them in an electric drying oven for 3 hours or when the weight was stable at a temperature of 105°C.

2-1-2 Protein estimation

The nitrogen ratio in types of grains and malts was estimated using the Microcaldel method according to what was mentioned in [2].A.A.C.C. (2008) and then multiplying the result by 5.7 to extract the percentage of protein.

2-1-3 Ash estimation

The percentage of ash in the types of grain and malt under study was estimated based on the method [1].A.O.A.C . (2008)

2-1-4 Fat estimation

The fat was determined according to the method referred to in [1]. (2008 A.O.A.C.) using Soxhlet apparatus using petroleum ether with a temperature of 40-60 °C.

2-1-5: Fibers estimation

It was estimated according to the method mentioned in [15].(Madhu et al., 2017).

2-1-6: Estimate the percentage of carbohydrates

The percentage of carbohydrates was estimated by calculating the difference between the total percentages of moisture, ash, fat, protein and fiber for the previous samples from the number 100 as mentioned [23]. (Pearson, (1970).

3-1 Estimation of mineral elements for white corn cultivars with germination stages

The measurement was conducted according to the method mentioned in [4]. (Akuru et al., 2018) at the University of Basra / College of Agriculture, the central laboratory of the Soil Department of the Atomic Absorption System Model Phoenix-986 AA Spectrophotometer - Biotech Engineering Management CO.,LTD.(UK) of origin.

4-1 Estimation of vitamin Bcomplex for white corn varieties in germination stages. Vitamin B1 estimation of white corn cultivars with germination stages

Vitamin estimation was conducted at the Ministry of Science and Technology, Baghdad, according to the method described in [29]. (Seal. and Chaudhuri. 2017) for water-soluble vitamins in an HPLC device, and the mentioned method was followed [(Sami et al., 2014) to estimate fat-soluble vitamins.

statistical analysis

Statistical analysis of the experiment was conducted for the data under study based on the Design Randomized Complete (DRC) and the results were analyzed within the ready-made statistical program Genstat and SPss based on the least significant difference between the averages R.L.S.D adjusted in the results at the level of probability (0.05).(Mohammed et al., 2019) studied the analysis of three samples of sorghum (yellow, red and white sorghum) to know the percentages of vitamins (B1, B3, B6) and mineral elements (Mg, Na, K, Ca, Fe, Zn, Cu and Mn).

Results and discussion

5-1 Chemical tests of sorghum cultivars before and after germination

The results of the statistical analysis of the sample showed sorghum cultivar (Kaffir) for different germination times of 96, 72 and 24 hours, and at a probability level of 0.05% that there were significant differences for the germination times and sorghum cultivar , where the results of moisture estimation in Table (1) indicated the excelled of the germination time of 96 hours for the cultivar Kaffir, which amounted to 17% While the moisture value decreased at the time of 24 hours for Kafir cultivar , as it gave a moisture percentage of 14.While the values of moisture estimation for the germination times of 72 hours were close to each other, 15 and 13%, and this difference in moisture percentages is due to the difference in cultivars, the period of soaking and germination, the wetting of the sample and the efficiency of the vital grains, which affects the moisture ratios, which is an important factor in wetting the sample. As the soaking process improves the nutritional value and product quality of the corn, due to the simultaneous fermentation of the starch inside the kernel, as well as a change in the flavor, smell and taste, while the germination process stimulates the hydrolysis enzymes because of its importance in reducing viscosity and producing high energy, and these results were in agreement With the findings of [36],[19](Teshome et al., 2018)). (Narsih and Harijono.2012) when he studied the effect of soaking and germination on sorghum.The results of the ash estimation in Table (1) and the results of the statistical analysis, which gave significant differences at the 0.01% probability level for the samples under study, showed that there was a decrease in the percentage of ash among the cultivars, the difference in germination times, as the highest percentage of ash for Kaffir cultivar at the time of germination 72 hours was 1.21% and the lowest percentage At a time of germination of 24 hours, that is, 0.39% non-germinating and this decrease in ash percentage is due to the high levels of protein and the low percentage of fat, which affects the mineral content in corn by decreasing minerals as a result of iron absorption. Ashes and this agreed with the findings [33].(Sorour et al., 2017).While the results of estimating the fat percentage of the sorghum cultivar with the results of the statistical analysis showed that there were significant differences between germination times at the 0.01% probability level for a decrease in fat percentages with an increase in the germination times of Kaffir cultivar at the time of germination 96 hours, which amounted to 1.01%, while at the time of germination 72 hours the value of The percentage of fat for sorghum cultivar Kaffir is 1.24%, while the percentage of fat in non-germination grains excelled these percentages of fat, as it was as follows for Kaffir cultivar of 2.20% and that this change in the percentage of fat is due to the different genetic composition of the varieties, as well as to water absorption and enzyme activity in the endosperm and digestion of reserve materials and as a result of the activity of the lipase enzyme, which breaks down fats into glycerides and fatty acids, and these results agreed with what was obtained by [19] .(Narsih and Harijono.2012).Table(1), which referred to protein values for cultivar under consideration and statistical analysis at a significant level of 0.01% because of significant differences between periods of germination and high protein percentage during germination. While the percentage of protein is a 72-hour average of 11%, While the protein Non-germination Kaffir cultivar 9.3% and this contrast in protein percentage is due to the biological changes during germination and activity of the enzyme, which affects the peptide, amino acids and the quantity of protein. Improving the quality of the proteins [19].(Narsih and Harijono.2012) and also for the different genotype of cultivars, the geographical location and the accreditation of protein on phosphorus and potassium and increased organic matter [33].(SOROUR et al, 2017) and [13].(Ktimi, 2004). While Table (1) showed the results of fiber percentage for the studied cultivars and the results of the statistical analysis at a significant level of 0.01%, which found significant differences between cultivars and germination times. Where the Kafir cultivar excelled at the time of germination of 96 hours in the fibers percentage and it was 1.21% and there was no significant difference in the fibers percentage for a time of 72 hours for the same cultivar, which amounted to 1.21%, and this difference is due to the low percentages of fat and high percentages of protein because of its effect on the percentages of fibers and that this difference in proportions. It may be due to the fact that sorghum contains fibers that are soluble in water and insoluble in water and because of the effect of germination time, where it increases the activity of the enzyme beta-amylase that breaks down carbohydrates and the enzyme alpha-amylase that breaks down starch.) . [13].(Katami, 2004).The results of the statistical analysis indicated that there were significant differences at the 0.01% probability level for the results of the carbohydrate ratios values that were reached by the difference in the above estimates and through Table (1) the results showed that the carbohydrate percentage differed according to the variety and the time of germination. Germination has a significant impact on the chemical ratings of moisture, ash, fat, protein, fiber, and carbohydrates, and an increase in nutritional value improvement [33,(Sorour et al., 2021)

Table (1) The chemical composition of the sorghum grains of the two Kafir and Giza cultivars with germination periods of 96, 72 and 24 hours

Estimates	Kafir cultivar			RLSD
	24 non-germination	72 non-germination	96 non-germination	
moisture	14±1.00	15± 0.100	17±1.000	0.668
ash	0.39±0.100	1.21±0.100	0.64±0.100	0.0744
fat	2.20 ±0.100	1.24±0.100	1.10±0.100	0.111
protein	9.3±0.100	11± 0.100	11±0.100	438.4
fiber	1.12±0.100	1.21±0.100	1.21±0.100	0.0744
carbohydrates	80.41±1.00	68.99±1.00	69.00±1.00	1.492
Total	100.0	100.0	100.0	

6-2 Follow-up of the development of mineral elements in sorghum grains (sorghum)

The results in Table (2) showed the effect of minerals as nutritional enhancers during different germination periods for a cultivar of sorghum. Through the results of the statistical analysis, it was shown that there were significant differences between the means at the probabilistic level $P<0.05$. The results showed that Fe was superior to the rest of the mineral elements estimated by the atomic absorption technique, where it was noted that the iron element in the germination period of 96 hours had the highest value of 664.50 µg / 100 g, while the iron element in the period of germination 72 hours was less by about 506 µg / 100 g.While the non-germinated Kaffir cultivar reached 392.75 µg/100g, and the table showed the values of the rest of the mineral elements, as they ranged between high and low for Mn according to the germination period and the lowest content at the non-growing period of Kaffir cultivar, while the cadmium element Cd had the highest values for Kaffir cultivar with the germination period of 96 hours, and the ratio was as follows: 47.25 µg/100 g. While the germination period of 72 hours for Kaffir cultivar reached the lowest values with a small difference of 34.00 µg/100 g, and Zn, the highest values for Kaffir 96 hrs were 44.25 µg/100 g and the lowest at 72 hours' germination period was 17.200 µg/100 g, while the Pd values of sorghum cultivar Kafir indicated With germination periods of 24, 72 and 96 hours, increasing and decreasing according to the germination period as follows: 18,200, 31.5 and 47,250 µg/100g.There were no significant differences between the values of the metallic elements cobalt, nickel, and chromium that originated from the contamination of grain or agricultural areas with industrial pollutants, and through the above results that were reached when studying that there are differences and differences between the values of mineral nutrients that are important to the body and that this difference, It is due to the environmental, agricultural, and genetic conditions of soil, plants, grains and pesticides given during the growing seasons (Tasie, and Gebreyes, (2020). The above results were in agreement with what was reached by when studying different cultivars of sorghum (sorghum).The results studied by [10] (Gerrano et al., 2016) indicated that there are differences in the mineral and protein contents of more than 20 mineral elements in sorghum that differ due to genetic and environmental influences and genotype according to the environment. The aim of this study was to determine the contents of eight mineral elements from (Ca, Fe, K, Mn, Na, P, Zn and Mg) and protein in sorghum genotypes, by contrast, showed significant differences in the contents of minerals and proteins. There was a significant relationship between zinc and iron and between protein, phosphorous and zinc.The results were in agreement with the findings of researchers [24] (Pontieri et al., 2014)) when studying varieties of sorghum (sorghum), which grains, in particular, are an important source of essential minerals due to their large daily containment of minerals among the major cereals used for food, feed, and industrial purposes all in the world, they are high in magnesium, iron and zinc, high in sodium and potassium, and low in calcium to phosphorous compared to other crops, These results are discussed with reference to the importance of minerals in human nutrition and suggest that, like wheat, it is possible to plan research programs to improve and select sorghum hybrids with high micronutrient content.

Table (2) Values of mineral elements for samples of sorghum under study

germination time samples	Cadmium	Lead	Zinc	Iron	Manganese	Nickel	Cobalt	Chrome
germination kafir	**0**	**0**	**0**	**19.950**	**392.75**	**10**	**18.200**	**9.75**
germination kafir 72 hours	**0**	**0**	**0**	**23.220**	**506**	**17.200**	**31.5**	**34.00**
germination kafir 96 hours	**0**	**0**	**0**	**36.500**	**664.50**	**44.250**	**47.250**	**47.25**
RLSD	**00.**	**0.00**	**0.00**	**0.0755**	**0.804**	**0.7266**	**0.1783**	**0.7336**

6-3 Follow-up of the development of water-soluble vitamins and lupus in fat for sorghum cultivars with germination periods of 24, 72 and 96 hours using HPLC technology.

The results under study indicated the concentrations of water-soluble vitamins and fat-soluble vitamins with different germination periods of 24, 72 and 96 hours. According to the results of the statistical analysis at the level of significance $P<0.05$, there are significant differences between the values of vitamins concentrations and the extent of their development, where between the table, shapes and profiles, the time of detention, absorption, and vitamin concentration in mg/g unit, as the water-soluble vitamins of Kaffir cultivar excelled in germination time of 96 hours for the vitamin Bcomplex group followed by time Germination of 72 hours with a significant difference, while the lowest concentration of sorghum grains was not germinated, and this difference and variance in the values of concentrations of vitamins during germination processes because of their importance in improving the chemo-vital traits, the work and activity of amylase enzymes and their development during germination and the increase in protein content. Glucose consumption [26]. (Rodriguez et al., 2012).

Table (3) Concentrations of water-soluble vitamins and their evolution during germination periods

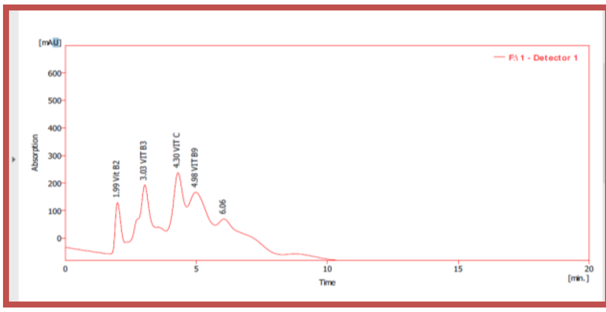
samples	B2	B3	B9	C
Kafir non-germination 24 hours	8.25	6.15	12.85	9.57
Kafir germination 72 hours	9.25	7.44	13.55	10.12
Kafir germination 96 hours	10.26	9.14	16.87	12.44

The results of the analysis of fat-soluble vitamins also showed a development in their concentrations and the extent of the sensitivity of the system, where they showed development in vitamins during the germination stages, an increase in their concentrations, and the retention time for each vitamin. With a significant difference at the probability level of $P<0.05$, then the values in the table indicated a decrease in the content of fat-soluble vitamins in the non-sprouted germination grains, while it was found that the 72-hour germination time of Kafir cultivar was excelled on the non-germination grains and that the development and increase in the concentrations of these vitamins that supply the body energy necessary for human health

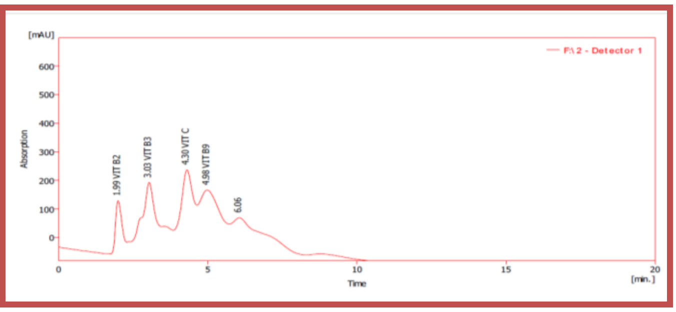
Table (4) Concentrations of fat-soluble vitamins

samples	**E**	**K**	**A**
Kafir non-germination 24 hours	15.22	4.89	17.58
Kafir germination 72 hours	17.49	6.11	19.58
Kafir germination 96 hours	20.15	8.49	22.58

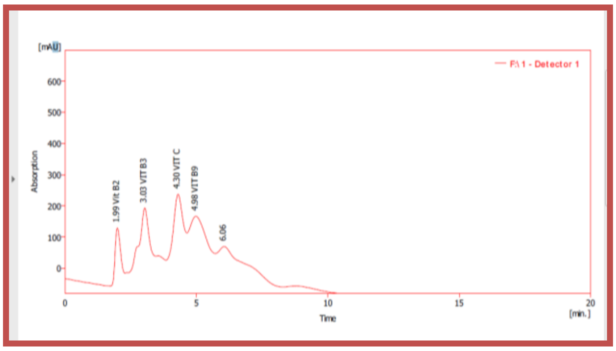
The results were in agreement with the findings of researchers (Zhang et al., 2018) when studying water-soluble and fat-soluble vitamins and because of its importance in improving the nutritional value and improving the bakery industry, The results were similar when diagnosed using high-performance liquid chromatography before and after germination for the concentrations of water- and fat-soluble vitamins [21]. (Ojo et al., 2020).



Sample(1) non-germination Kafir

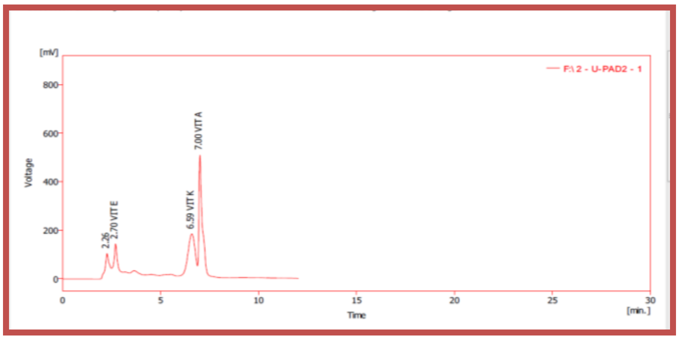


Sample(2) Kafir germination 72 hours

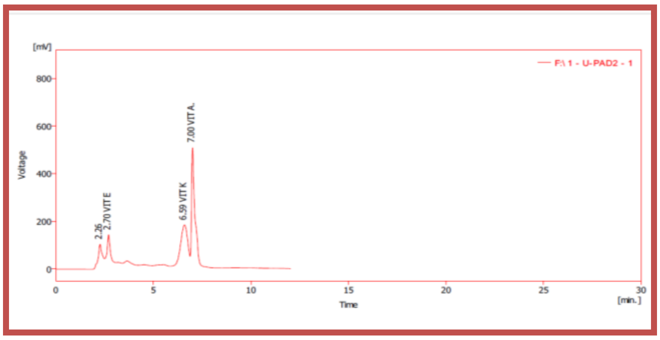


Sample(3) Kafir germination 96 hours

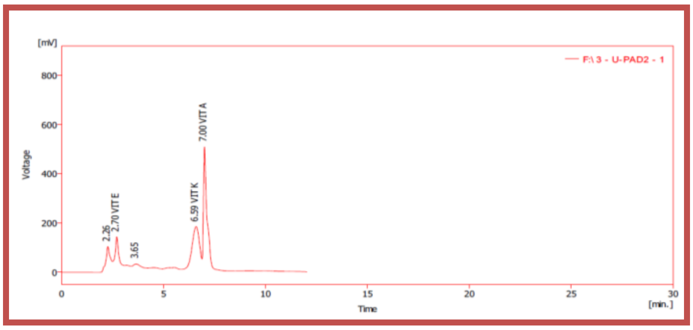
High-performance liquid laurel chromatographic profiles of water-soluble vitamins of .sorghum (Kafir) with different germination periods



Sample(1) non-germination Kafir



Sample(2) Kafir germination 72 hours



Sample(3) Kafir germination 96 hours

High-performance gas liquid chromatography profiles for the fat-soluble vitamins of .(sorghum cultivar (**Kafi**

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