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CORRELATION DEPENDENCE OF CAROTINE CONTENT IN VARIETIES AND VARIETY SAMPLES OF ALFALFA OF KAZAKHSTANI AND FOREIGN SELECTION

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The results of assessing the quality of hay of alfalfa varieties and variety samples of Kazakhstani and foreign selection on carotene content and dependence of carotene content on dry matter and biochemical parameters are presented in the article. The research is related to the subject of the international project "GS19001 – Use of wild related agricultural crops for developing drought-resistant alfalfa and its distribution among subsistence farmers in Kazakhstan, China and Chile". The research was carried out in 2021 on the experimental fields of "Kokshetau Experimental Production Farm" LLP (Shagalaly rural area), located in the northern part of the hilly and plain zone of the Akmola region of the Republic of Kazakhstan. 35 varieties and variety samples of alfalfa obtained by Kazakhstani and foreign scientists were studied in the ecological nursery. The seeds were sown in the second decade of May. The content of carotene in varieties and variety samples of alfalfa ranged from 18.03 to 20.21 mg/kg. The correlations between carotene and the studied parameters are weak positive and negative, medium positive.

Key words: Alfalfa Medicago sativa L., green matter, carotene, carotene content in dry matter.

ҚАЗАҚСТАНДЫҚ ЖӘНЕ ШЕТЕЛДІК СЕЛЕКЦИЯНЫҢ ЖОҢЫШҚА СОРТТАРЫ МЕН СОРТУЛГІЛЕРІНДЕ КАРОТИН ҚҰРАМЫНЫҢ КОРРЕЛЯЦИЯЛЫҚ ТӘУЕЛДІЛІГІ

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Мақалада каротин құрамы және каротин құрамының құрғақ зат пен биохимиялық көрсеткіштерге тәуелділігі бойынша қазақстандық және шетелдік селекцияның жоңышқа сорттары мен сорттарының пішен сапасын бағалау нәтижелері келтірілген. Зерттеулер "GS19001 – Құрғақшылыққа төзімді жоңышқа алу үшін жабайы туыстас ауылшаруашылық дақылдарын пайдалану және оны Қазақстан, Қытай және Чили аумағында фермерлер арасында тарату" халықаралық жобасының тақырыбымен байланысты. Зерттеулер Қазақстан Республикасы Ақмола облысының шоқылы-жазық аймағының солтүстік бөлігінде орналасқан "Көкшетау тәжірибелік-өндірістік шаруашылығы" ЖШС-де (Шағалалы ауылы) жүргізілді. Жоңышқаның сорттары және сортүлгілері таза сүрі жерде себілді. Экологиялық көшеттікте қазақстандық және шетелдік ғалымдар шығарған жоңышқаның 35 сорты мен сорт үлгілері зерттелді. Жоңышқа сорттары және сортүлгілерінде каротин мөлшері 18,03-ден 20,21 мг/кг аралығында ауытқиды. Каротин мен зерттелген көрсеткіштер арасындағы корреляциялық байланыстар әлсіз оң және теріс, орташа оңға тең.

Түйінді сөздер: жоңышқа, көкбалауса, каротин, құрғақ заттағы каротин мөлшері.

КОРРЕЛЯЦИОННАЯ ЗАВИСИМОСТЬ СОДЕРЖАНИЯ КАРОТИНА У СОРТОВ И СОРТООБРАЗЦОВ ЛЮЦЕРНЫ КАЗАХСТАНСКОЙ И ЗАРУБЕЖНОЙ СЕЛЕКЦИИ

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В статье приведены результаты оценки качества сена сортов и сортообразцов люцерны казахстанской и зарубежной селекции по содержанию каротина и зависимости содержания каротина от содержания сухого вещества и биохимических показателей. Исследования связаны с темой международного проекта "GS19001 – Использование диких родственные сельскохозяйственных культур для выведения засухоустойчивой люцерны и ее распространение среди фермеров, ведущих натуральное хозяйство на территории Казахстана, Китая и Чили". Исследования проведены в 2021 году на опытных полях ТОО "Кокшетауское опытно-производственное хозяйство" (с. Шагалалы), расположенный в северной части сопочно-равнинной зоны Акмолинской области Республики Казахстан. В экологическом питомнике изучены 35 сортов и сортообразцов люцерны, полученные казахстанскими и зарубежными учеными. Содержание каротина в сортах и сортообразцах люцерны колебалось от 18,03 до 20,21 мг/кг. Корреляционные связи между каротином и изученными параметрами слабая положительная и отрицательная, средняя положительная.

Ключевые слова: люцерна посевная *Medicago sativa* L., зеленая масса, каротин, содержание каротина в сухом веществе.

Introduction

The legume crop alfalfa is one of the oldest fodder crop on the Earth. There are three centers of its origin found in the literature: the European-Siberian, the Near Eastern-Asian, and the Central Asian. Other centers such as the Mediterranean and North American found in the literature are considered secondary. The secondary centers of origin, according to many researchers, play an important role in the evolution, selection and distribution of cultivated forms of alfalfa around the globe [1, p.13].

Alfalfa is truly called as "the nature's gift" and "the queen of grasses" in the USA and in many other countries because of its fodder and other valuable properties. Due to the above-mentioned properties, alfalfa like other legume fodder crops can be considered as a generally accepted forage plant, which has become widespread in many countries of the world. However, according to the scientists the specific weight of legume fodder crops remains low (not more than 30%), determining not only the protein nutrition of forage, but also soil fertility [2, p.15]. The same problem is faced in Kazakhstan. At present, agricultural producers focused on livestock production, including personal subsidiary farms of the population, experience enormous difficulties in providing fodder for animals during the stabling period. To involve additional land resources, to increase the level of provision with green, succulent and coarse fodder, the area of which in the Akmola region exceeds more than 2 million hectares, and to transform these lands into highly productive hayfields and pastures, fodder grass seeds will be required. Implementing this programme, more than 200,000 hectares of fallow land need to be developed each year over the next decade. About 2 thousand tons of fodder grass seeds, at a conservative estimates, will be required annually to transform these lands into hayfields and pastures [3, p.7]. All of these reasons contribute to a decrease in the grass area, although alfalfa is superior to many legume grasses in terms of its economic value.

As the most valuable fodder crop, due to the high ecological flexibility, improved quality and high productivity of fodder, resistance to adverse soil and climatic conditions such as winter hardiness, drought resistance, etc, alfalfa is able to solve the problem of eliminating the deficiency of carotene as a source of vitamin A in many regions of the Republic of Kazakhstan [4, p.15]. Alfalfa is distinguished from other fodder crops by its productivity, longevity, exceptional ability to grow in a variety of natural conditions, multi-purpose use: mowed green fodder, pasture fodder (grass mixtures) hay, haylage, green chopping, combined silage, fodder briquettes, protein concentrated feed-stuffs; beet pulp and green plant sap, recovery of soil fertility due to atmospheric nitrogen fixation. Alfalfa can be a source of essential amino acids [5, p.4].

The carotene content of feed is important. The biological significance of carotenoids for farm animals is much higher. Carotene is a source of provitamin A. It also protects animals' blood hemoglobin from the damaging effects of nitrates, stimulates nonspecific natural resistance factors, and protects the body from the carcinogenic effects of aggressive pro-oxidants. In animals, β -carotene is a precursor of the chromophore of the visual pigment rhodopsin and steroid hormones [6, p. 416].

When there is carotene deficiency in cows, reproductive disorders such as weak ovulation, silent ovulation, prolonged ovulation, underdeveloped ovarian body are observed, which leads to increased embryonic mortality, failure of sexual cycle, increased abortion at 18-20 weeks of pregnancy, birth of weak non-viable young calves. Newborn calves show stunting, purulent discharge from the eyes and nose,

lethargy, diarrhoea and then bronchopneumonia [7, p. 32-37].

The content of carotene in the feed is directly proportional to its content in milk and butter. In the arid steppe subzone of the southern carbonate chernozems in the Akmola region the weight content of carotene in the dry matter of alfalfa hay ranged from 47.5 mg/kg in the Stepnyanka variety to 71.90 mg/kg in the Raykhan variety. The content of carotene in absolutely dry matter varied from 31.5 mg/kg (the Northern hybrid alfalfa variety) to 65.3 mg/kg (the Sinskaya alfalfa variety) [8, p.10-11].

According to Kirsanov V.A., both second – and third-year plants show a maximum of carotene during cooler periods and a decrease in carotene content during hot weather. It has also been noted that the amount of positive temperatures, the amount of precipitation, the duration of the growing season, and the level of solar radiation affect the supply of nutrients and, consequently, the chemical composition of plants. During the period of plant growth and development, cool temperature and low moisture supply contribute to a high content of carotene. Poleyva I.P. et al. also note that hydrostress conditions increase the biosynthesis of photosynthesis pigments, and carotene is one of the essential components of the pigment systems of photosynthetic plants. The carotene content is also determined by the genetic potential of the crop [9, p. 42].

Materials and research methods

The studies were carried out in 2021 on the experimental fields of "Kokshetau Experimental Production Farm" LLP (Shagalaly rural area), located in the northern part of the hilly and plain zone of the Akmola region in Zerenda district of the Republic of Kazakhstan.

The soil of the experimental plot is represented by ordinary chernozem, medium thick, medium humus, with a depth of the humus horizon of 25-27 cm and an average humus content of 4.21%. In the arable layer of 0-40 cm of soil, nitrate nitrogen is 17.0 mg, mobile phosphorus is 7.1 mg, exchangeable potassium is 35.0 mg per 1 kg of soil. Consequently, the availability of nitrogen is high, phosphorus is low, and potassium is high. According to the mechanical composition, the soil is heavy loamy, the weight in the arable horizon is 1.19 g/cm³ and it is 1.30 g/cm³ on average in the metre-deep layer. The permanent wilting point is 13%.

The research is related to the subject of the international project "GS19001 – Use of wild related agricultural crops for developing drought-resistant alfalfa and its distribution among subsistence farmers in Kazakhstan, China and Chile". According to the project an ecological nursery was founded on the experimental fields of "Kokshetau Experimental Production Farm" LLP by the scientists of the laboratory of fodder crops of "Kazakh Research Institute of Agriculture and Crop Production" LLP (Almaty).

The objects of study are alfalfa varieties and variety samples of foreign and Kazakhstani selection: Alta Sierra 2, Alta Sierra 1, K 270, TA 37 HOW Long, APG 6567, APG 58577, K 271, DT 1, Titan 7, K 269, APG 58575, APG 58574, Stamina GT 6, APG 38052, SARDI 7, Series 2, APG 45677, Q75, L56, APG 19018, Aurora, SARDI Grazer, APG 35169, APG 6019, K267, Zhangcao, Forse 5, K 268, DT 2, STAMINA 5, Semerechinskaya local, Turkistan 15, Kokorai, Osimtal, Kapchagaiskaya 80, DARHAN 90.

When sowing alfalfa in its pure form, pre-sowing tillage should be carried out at a very shallow depth and well-settled soil. The soil surface should be leveled and tight, but it should provide optimal seed embedding.

The sowing method was row cropping (row spacing 15 cm). All numbers were laid in 3-fold repetition. The plot area is 1 m². The border check irrigation Side protective strips 0.7 m, end – 10 m. Harvesting of plants for green matter was carried out at the beginning of the flowering phase.

The border strips were 0.7 m, headlands were 10 m. Harvesting of plants for herbage was carried out at the beginning of the flowering phase.

The meteorological conditions in 2021 were characterized as follows: during the mowing period (growing-budding, budding-flowering) in the first ten-day period of June, the HTC (hydrothermal coefficient) was 0.3 (very dry); in the second ten-day period it was 0.9 (dry); in the third ten-day period the hydrothermal coefficient was 0.1 (dry). In the first decade of July, the HTC was equal to 0.3 (very dry); in the second decade it was 1.9 (wet); in the third decade was 0.02 (very dry). HTC in June was 0.14, and it was 0.2 in July.

Average hay samples were taken from 35 varieties and variety samples of alfalfa to determine the content of carotene in July 2021. It had an initial moisture content of 75-80 %. Drying was carried out in the laboratory without sunlight. The foliage was mechanically ground to a particle size of 10-20 mm just before carotene determination.

The chemical assessment of alfalfa varieties for carotene content was carried out in the laboratory of "AgroComplexExpert" LLP according to generally accepted methods.

Results and discussion

Alfalfa sown in one field can produce 3-6 complete cuttings over a period of 4-7 years. This corresponds to 500-600 kg/ha of green matter, 100-120 kg/ha of fodder, 18-19 kg/ha of digestible protein. Under the conditions of "Kokshetau experimental-production farm" LLP alfalfa is grown under non-irrigated rainfed conditions. Alfalfa is not usually used in the first year of life under the conditions of Northern Kazakhstan. Average green matter samples were taken from 35 alfalfa varieties and variety samples. Drying

was carried out in the laboratory without sunlight. The foliage was mechanically ground to a particle size of 10-20 mm.

The harvested alfalfa herbage was dried up to 8-10% of moisture. This moisture content is necessary for storing during the winter period.

The carotene content of alfalfaherbage was determined on the Foss InfraXact express analyzer. The samples were analyzed in the bowls placed in the receiving unit of the instrument. The analyser works with ISIScan™ software which supports the latest calibration technologies. Spectral data is obtained by measuring the radiation transmission intensity of the analyzed object in the near infra-red region.

Figure 1 shows the results of experimental studies to determine carotene content in dried alfalfa. During the comparative assessment of varieties and variety samples of alfalfa on ordinary chernozems with a depth of humus accumulated horizon of 25-27 cm and an average humus content of 4.21%, the weight ratio of carotene ranged from 18.03 to 20.21 mg/kg (Fig. 1).

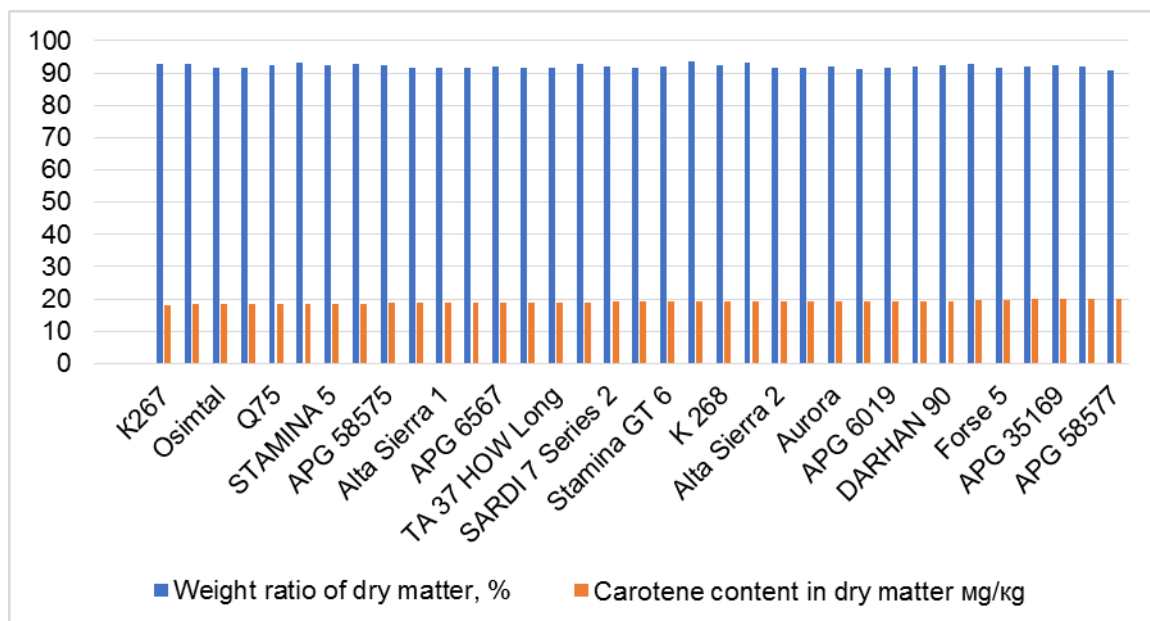


Figure 1 – Carotene content in varieties and variety samples of alfalfa (mg/kg)

In varieties and variety samples of alfalfa K267, Semerechinskaya Local, Osimtal, APG 38052, Q75, APG 45677, STAMINA 5, DT 1, APG 58575, Kapchagaikskaya 80, Alta Sierra 1, Kokorai, APG 6567, K 269 carotene content varied from 18.03 to 18.96 mg/kg; TA 37 HOW Long, Turkistan 15, SARDI 7 Series 2, K 271, Stamina GT 6, L56, K 268, SARDI Grazer, Alta Sierra 2, K 270, Aurora, APG 19018, APG 6019, Zhangcao, DARHAN 90, DT 2, Forse 5, APG 58574, APG 35169 – from 19.02 to 19.83 mg/kg; APG 35169 – 20.07 mg/kg; Titan 7 – 20.13 mg/kg; APG 58577 – 20.21 mg/kg.

According to M.A. Smurygin, hay fodder can be assessed by a point system on the content of carotene in the dry matter (Table 1).

Table 1 – Assessment of hay by carotene content

Carotene content (in mg) per 1 kg of dry matter	Points
35 and more	10
25-35	8
15-24	5
5-15	2
less than 5	0

According to Smurygin M.A. all varieties and variety samples were rated by carotene content in the dry matter of alfalfa hay as 5 points (the point system) [10, p.19, 11, p. 22-23].

The dependence of carotene content on parameters of chemical composition of alfalfa hay was also calculated (Fig. 2).

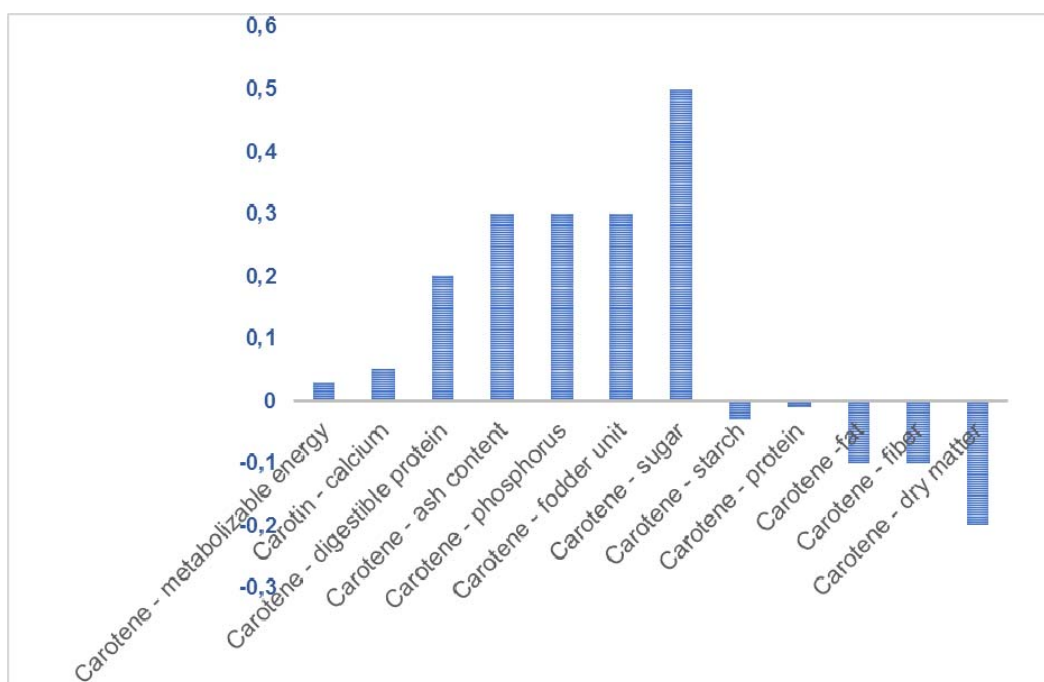


Figure 2 – Correlation dependence (r) of carotene content from some parameters of chemical composition of alfalfa hay

The dependence of carotene content on the parameters of chemical composition of alfalfa hay was calculated. The alfalfa growth and development were formed under unfavorable conditions. HTC was less than 1. In selection only those relations are of interest, in which the correlation coefficient is positive or negative high and very high or low if the correlation is regular at 1 % and 5 % level of significance.

It is in the interest of the selective practice to use only those correlations where the correlation coefficient is positive or negative high and very high or low if the correlation is consistent at the 1% and 5% significance levels.

In the second and third year of alfalfa life, carotene content had a high positive correlation with crude protein (0.737**), magnesium (0.736*) and a high negative correlation with nitrogen (-0.711**), crude ash (-0.777**) [12, p.428].

The results showed that many of the studied parameters are interrelated to varying degrees. The carotene content in alfalfa samples from the 6th year of life was unequally influenced by the studied parameters. At the sixth year of alfalfa life, the carotene content was primarily determined by calcium content (0.05), metabolizable energy (0.03), digestible protein (0.2), feed unit (0.3), phosphorus (0.3), ash content (0.3) (positively average between carotene and sugar (0.5); negative weak relationship between carotene was determined by crude protein (-0.01), fat (-0.1), fiber (-0.1), dry matter (-0.2), and starch (-0.03).

Conclusion

Determination of carotene content in alfalfa varieties and variety samples in the sixth year of life showed slight variation from 18.03 to 20.21 mg/kg: 5 points according to Smurygin M.A.

The alfalfa varieties and variety samples with low metabolizable energy, calcium and high starch and protein content can be markers for the selection of forms with higher carotene content.

Promising source material and the results of the research will be recommended for targeted use in selection of the Scientific Research Institute.

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ЗАСУХОУСТОЙЧИВОСТЬ СОРТОВ И СОРТООБРАЗЦОВ ЛЮЦЕРНЫ КАЗАХСТАНСКОЙ И ЗАРУБЕЖНОЙ СЕЛЕКЦИИ

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В статье приведены результаты стрессоустойчивости сортов и сортообразцов люцерны, произрастающие на территории трех стран. Исследования связаны с темой международного проекта "GS19001 – Использование диких родственных сельскохозяйственных культур для выведения засухоустойчивой люцерны и ее распространение среди фермеров, ведущих натуральное хозяйство на территории Казахстана, Китая и Чили". Недостаток влаги в период роста и развития растений существенно отразилось на урожайности кормовых культур. Также засуха заметно влияет на экономическую и экологическую ситуацию в странах. Изменение климата в этом направлении актуализировала эту проблему. Поэтому в исследованиях особое внимание уделялось изучению засухоустойчивости образцов люцерны.

Исследования проведены в ТОО "Кокшетауское опытно-производственное хозяйство" (с. Шагалалы), расположенный в северной части сопочно-равнинной зоны Акмолинской области Зерендинского района Республики Казахстан. Почвы опытного участка – черноземы обыкновенные, по механическому составу – тяжелый суглинок слабохрящеватый, запасы подвижных форм фосфора оцениваются как низкие, калия высокие.

В селекции на повышение засухоустойчивости применены полевые методы оценки. Засухоустойчивость определена в период максимального проявления засухи – визуальная оценка по числу зеленых листьев, выраженных в процентах. Были выделены перспективные образцы по засухоустойчивости: К 271, Forse 5, Zhangcao, DT 1. Выделенные сортообразцы по засухоустойчивости будут использованы в качестве исходного материала в селекции кормовых культур.

Ключевые слова: кормовая культура, люцерна, сорта и сортообразцы люцерны, засуха, засухоустойчивость, корреляция.

ҚАЗАҚСТАНДЫҚ ЖӘНЕ ШЕТЕЛДІК СЕЛЕКЦИЯ ЖОҢЫШҚА СОРТТАРЫ МЕН СОРТТАРЫНЫҢ ҚҰРҒАҚШЫЛЫҚҚА ТӨЗІМДІЛІГІ

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Мақалада үш елдің аумағында өсетін жоңышқа сорттары мен сорт үлгілерінің стресске төзімділігінің нәтижелері келтірілген. Зерттеулер "GS19001 – Құрғақшылыққа төзімді жоңышқа