

COMPARATIVE ANALYSIS OF COTTONSEED OIL CONTENT AND FATTY ACID COMPOSITION

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Abstract: The study investigated the oil content, fatty acid composition, and oil-yield indicators of cottonseeds from Xinjiang varieties of China and cotton varieties cultivated in Uzbekistan. Comparative analysis showed that Xinjiang varieties are distinguished by higher oil yield, whereas local varieties demonstrate stable adaptation to agroclimatic conditions. The prospects for using breeding varieties rich in oleic and linoleic acids in the fat-and-oil industry were evaluated.

Keywords: cottonseed, cottonseed oil, oil content, fatty acids, Chinese varieties, local varieties, breeding.

1. INTRODUCTION

The growth of the world's population, the acceleration of urbanization, and the increasing demand for healthy nutrition require an expansion of vegetable oil production. Vegetable oils are among the main sources of unsaturated fatty acids essential for the human body and therefore have strategic importance in the food industry. In this respect, cottonseed is not only a valuable raw material for the textile industry but also an important resource for the fat-and-oil industry. Cottonseed contains a significant amount of oil and protein, while cottonseed oil is rich in biologically active unsaturated fatty acids such as linoleic and oleic acids. These fatty acids play an important role in supporting cardiovascular function, normalizing lipid metabolism, and strengthening human health.

In recent years, extensive research has been conducted in the world's major cotton-producing countries to develop and introduce cotton varieties with high oil content. In particular, modern cotton varieties developed in the Xinjiang region of China are characterized by high yield, elevated oil content in the seed, and favorable technological properties for processing. Local varieties developed under the conditions of Uzbekistan, in turn, are characterized by their adaptation to drought, salinity, and sharp climatic fluctuations.

Cottonseed oil content is formed through the interaction of genetic and environmental factors. While varietal genotype determines oil synthesis and fatty acid composition, temperature, moisture, solar radiation, and soil conditions significantly affect the degree of oil accumulation. Therefore, a comparative assessment of the oil-content indicators of different varieties makes it possible to identify high-oil varieties that are promising for industrial use.

One of the important tasks facing the fat-and-oil industry of Uzbekistan is to increase oil yield from cottonseed, improve product quality, and enhance processing efficiency. Comparative study of the biological and technological characteristics of foreign and local cotton varieties is of considerable scientific and practical importance in addressing these tasks. The purpose of this study is to comparatively assess the oil-content indicators, fatty acid composition, oil-extraction efficiency, and industrial prospects of cottonseeds from varieties developed in Xinjiang, China, and local varieties cultivated in Uzbekistan.

2. RESEARCH OBJECTS AND METHODS

The research objects were the Xinluzhong-37, Xinluzhong-51, CCRI-70, and Shida-K9 cotton varieties developed in the Xinjiang region of China, as well as the S-6524, Bukhara-102, Sulton, and Khorezm-127 varieties widely cultivated in Uzbekistan.

During the study, the oil content of cottonseed samples was determined by extraction using a Soxhlet apparatus. The fatty acid composition of the obtained oil samples was analyzed by gas chromatography. The results were statistically processed, and differences between the varieties were comparatively evaluated.

3. COTTONSEED OIL-CONTENT INDICATORS

The research results showed that the oil content of cottonseeds from Chinese varieties was higher than that of local varieties. The average oil content in Chinese varieties was 24–25%, whereas in local varieties this indicator was approximately 20–21%. This indicates that Chinese varieties are promising raw materials for the oil-processing industry. Comparative data on cottonseed oil content in Chinese and local cotton varieties are presented in Table 1.

Table 1

Oil content of cottonseed from Chinese and local varieties

Variety	Oil content (%)
Xinluzhong-37	24.8
Xinluzhong-51	24.1
CCRI-70	23.6
Shida-K9	25.2
S-6524	20.4
Bukhara-102	21.1
Sulton	20.8
Khorezm-127	20.2

The results demonstrate that the genetic characteristics of varieties have a significant effect on oil accumulation. In Chinese varieties, oil content ranged from 23.6 to 25.2%, with an average of 24.4%. In local varieties, this indicator ranged from 20.2 to 21.1%, averaging 20.6%.

According to the table, the highest oil content (25.2%) was recorded in the Shida-K9 variety. The high oil-accumulation capacity of this variety indicates that special attention was paid to seed-quality indicators during breeding. Xinluzhong-37 and Xinluzhong-51 also had oil contents of 24.8 and 24.1%, respectively, and are promising raw materials for industrial processing.

Among local varieties, the highest oil content was identified in Bukhara-102 (21.1%), while the lowest value was observed in Khorezm-127 (20.2%). However, these varieties are distinguished by their adaptation to various soil and climatic conditions of Uzbekistan, high productivity, and good fiber quality.

When the average values were compared, the oil content of Chinese varieties was found to be 3.8 percentage points, or approximately 18.4%, higher than that of local varieties. This difference is an important economic indicator for fat-and-oil enterprises, because each additional percentage point of oil in the processed raw material makes it possible to obtain more finished product.

The table results also show that the genotype factor has a strong effect on cottonseed oil content. This expands the possibility of developing new high-oil

breeding varieties adapted to Uzbekistan's conditions through hybridization of high-oil Chinese varieties with local varieties.

Table 2 presents the relative amounts of the main fatty acids in cottonseed oil: palmitic, stearic, oleic, and linoleic acids.

Table 2

Analysis of the fatty acid composition of oils from Chinese and local cotton varieties

Indicator	Chinese varieties (%)	Local varieties (%)
Palmitic	21.5	23.1
Stearic	2.5	2.8
Oleic	19.3	17.1
Linoleic	55.2	53.8

Fatty acid composition is one of the main factors determining the nutritional value, oxidative stability, shelf life, and technological properties of oil. According to the table, linoleic acid had the largest share in both groups of oils. Its content was 55.2% in Chinese varieties and 53.8% in local varieties. Linoleic acid belongs to the omega-6 group and is an essential fatty acid for the human body. Its high level increases the biological and nutritional value of cottonseed oil.

The oleic acid content in oils from Chinese varieties was 19.3%, which was 2.2 percentage points higher than in local varieties (17.1%). A higher oleic acid content increases resistance to oxidation, slows the formation of peroxide compounds, and prolongs product shelf life. Therefore, oils obtained from Chinese varieties may have certain advantages during refining and storage.

Palmitic acid accounted for 21.5% in Chinese varieties and 23.1% in local varieties. Similarly, the stearic acid content was slightly higher in local varieties (2.8%) than in Chinese varieties (2.5%). These saturated fatty acids affect the hardness and crystallization properties of oil. Therefore, oils obtained from local varieties may have certain technological advantages in the production of structured fats, margarine, and confectionery fats.

An overall assessment of the fatty acid composition shows that oils from Chinese varieties have high quality indicators from nutritional and functional

perspectives. Local varieties, due to their somewhat higher share of saturated fatty acids, may be effectively used in the production of certain technological products. Thus, the results of Table 2 show that Chinese varieties have a higher proportion of unsaturated fatty acids, whereas local varieties contain relatively more saturated fatty acids that ensure structural stability. This confirms that both gene pools have specific advantages in the fat-and-oil industry and indicates the need for their targeted use in breeding programs.

Figure 1 compares the cottonseed oil-content indicators of varieties introduced from China and those cultivated in Uzbekistan.

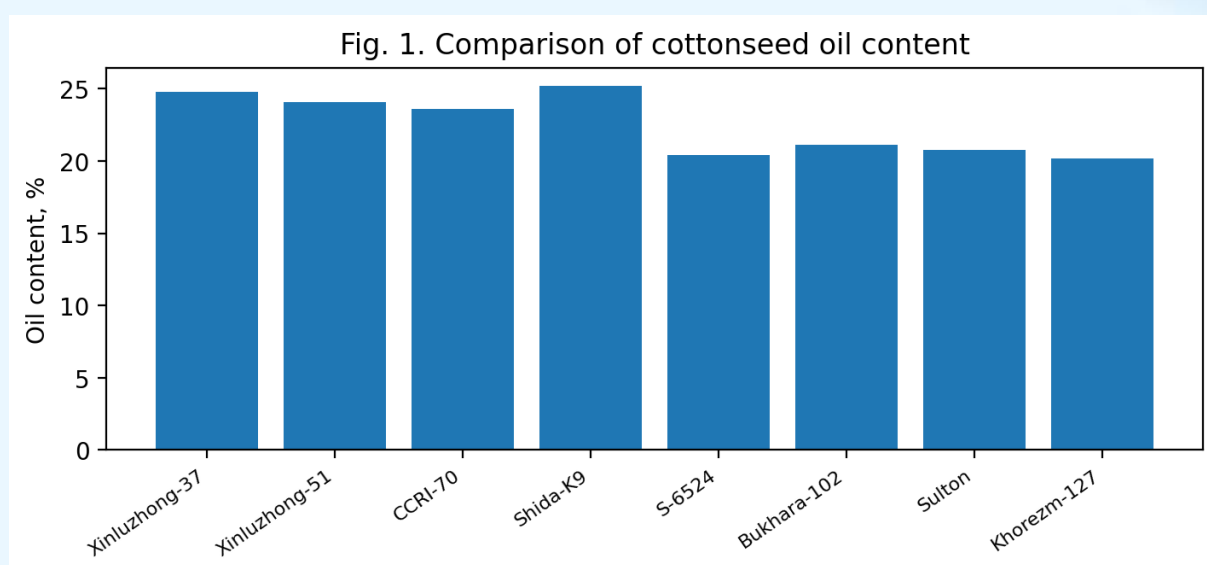


Figure 1. Analysis of cottonseed oil-content indicators of Chinese and local cotton varieties

According to the results, the oil content of Chinese-bred varieties ranged from 23.6 to 25.2%, with an average value of 24.4%. In local varieties, this indicator ranged from 20.2 to 21.1%, averaging 20.6%. The highest oil content was observed in Shida-K9 (25.2%), and the lowest in Khorezm-127 (20.2%). The difference between the average values was 3.8 percentage points, indicating that the oil content of Chinese varieties was approximately 18–19% higher than that of local varieties.

These results may indicate higher activity of genes responsible for lipid biosynthesis in Chinese varieties. In addition, because increasing seed oil content was one of the main objectives in breeding these varieties, metabolic processes associated with oil accumulation may occur more intensively in them. In local varieties, breeding has primarily focused on traits such as yield, technological fiber

quality, drought resistance, and salinity tolerance, while oil content has developed as a secondary trait.

From an industrial point of view, this difference is economically significant. For example, when 1,000 tonnes of cottonseed are processed, Chinese varieties can yield up to 35–40 tonnes of additional oil. This can increase enterprise profitability while reducing production cost. Therefore, testing high-oil Chinese varieties under local agroclimatic conditions and hybridizing them with the local gene pool are promising directions.

Figure 2 shows the differences between Chinese and local varieties in the content of the main fatty acids in cottonseed oil: palmitic, stearic, oleic, and linoleic acids.

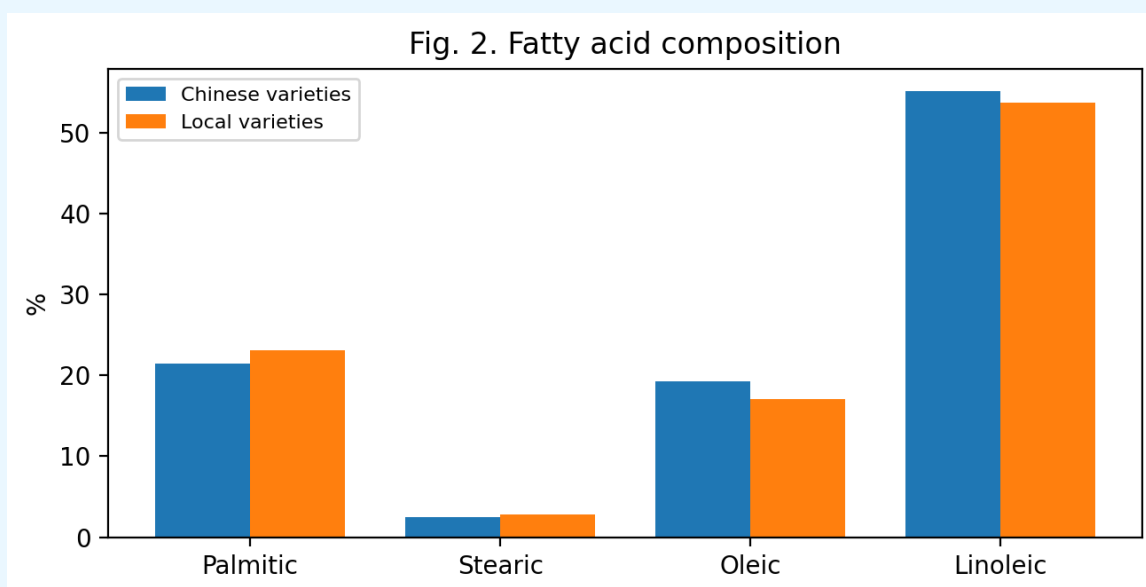


Figure 2. Analysis of the fatty acid composition of oils from Chinese and local cotton varieties

The analyses showed that linoleic acid represented the major share in both groups of oils, accounting for 55.2% in Chinese varieties and 53.8% in local varieties. Linoleic acid is an important unsaturated fatty acid of the omega-6 group; it is not synthesized in the human body and therefore must be obtained through food. For this reason, the high biological value of cottonseed oil is closely related to this component.

The oleic acid content in Chinese varieties was 19.3%, higher than in local varieties (17.1%). A greater amount of oleic acid increases oil resistance to

oxidation, extends shelf life, and improves thermal stability during frying. This is an important technological advantage in the food industry.

In local varieties, the proportions of palmitic (23.1%) and stearic (2.8%) acids were slightly higher than in Chinese varieties. These saturated fatty acids increase oil hardness and affect crystallization temperature. As a result, oils obtained from local varieties may have certain advantages in the production of margarine and specialty fat products.

Analysis of the fatty acid composition shows that oils from Chinese varieties are promising from nutritional and functional perspectives due to their higher oleic and linoleic acid contents. Local varieties may be important in technological processing, especially in the production of structured fats and modified fat products.

Overall, the results shown in Figures 1 and 2 indicate that cottonseeds of Chinese varieties have certain advantages in terms of oil content and oil quality. At the same time, the ecological adaptability and technological characteristics of local varieties confirm the need to preserve them as valuable genetic resources for breeding. In the future, developing new cotton varieties that combine high oil content, high oleic acid content, and adaptation to local conditions on the basis of these two gene pools will be one of the important scientific directions for development of the fat-and-oil industry.

Table 3 compares the amount of main products obtained by industrial processing of cottonseeds from Chinese and local cotton varieties, as well as their economic efficiency indicators.

Table 3

Analysis of the economic efficiency of processing cottonseeds from Chinese and local cotton varieties

Indicator	Chinese varieties	Local varieties
Oil yield, t	240–250	200–210
Cottonseed meal, t	450–500	500–520
Income index	1.18	1.00

The analysis was performed for the processing of 1,000 tonnes of cottonseed, and the results clearly demonstrate the relationship between varietal oil content and

processing efficiency. According to the table, 240–250 tonnes of oil can be obtained from cottonseeds of Chinese varieties, whereas the corresponding value for local varieties is 200–210 tonnes. On average, Chinese varieties can yield up to 40 tonnes more oil than local varieties. This is explained by their higher oil-content indicators and creates an important economic advantage for processing enterprises.

An increase in oil production directly affects the total revenue of an enterprise because cottonseed oil is the main finished product of the fat-and-oil industry and accounts for the largest economic share in the product cost structure. As a result, processing the same amount of raw material makes it possible to obtain greater profit from Chinese varieties.

The table also compares cottonseed meal yield. In local varieties, the amount of meal was 500–520 tonnes, slightly higher than in Chinese varieties, where it ranged from 450 to 500 tonnes. This is explained by the fact that as the oil content in cottonseed increases, the proportion of residual dry matter decreases relatively. However, cottonseed meal is a protein-rich feed product widely used in animal husbandry. Therefore, the higher meal yield of local varieties is a certain advantage from the perspective of feed production.

The analysis of the income index confirms the economic advantage of Chinese varieties. In the table, this indicator is 1.18 for Chinese varieties, while for local varieties it was conventionally taken as 1.00. This means that the economic efficiency of production based on Chinese varieties is approximately 18% higher. This result is primarily associated with greater oil output and a larger volume of finished products.

In addition, the use of high-oil varieties can reduce energy consumption, improve extraction efficiency, and optimize production costs. At the same time, when imported varieties are used, it is also necessary to consider seed costs, the level of adaptability, and agronomic risks.

Overall, the results of Table 3 show that processing cottonseeds from Chinese varieties is economically more efficient. Local varieties are distinguished by higher meal yield, good adaptation to agroclimatic conditions, and stability of the raw-material base. Therefore, the development of new breeding varieties combining the

high oil content of Chinese varieties with the adaptability of local varieties is one of the important directions for development of the fat-and-oil industry. This will contribute to increasing the volume of products obtained from cottonseed, producing import-substituting products, and ensuring national food security.

CONCLUSION

The analyses showed that the oil content of cottonseeds obtained from Chinese varieties is on average 15–20% higher than that of local varieties, which increases oil-production efficiency. Local varieties, however, have advantages in terms of agroclimatic adaptability and stability of the raw-material base. In the future, development of high-oil, high-oleic, and low-gossypol varieties based on Chinese and local gene pools will be one of the important directions for development of Uzbekistan's fat-and-oil industry.

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