



ASSESSMENT OF THE QUALITY OF FOOD-GRADE SOYBEAN SEEDS INTENDED FOR PROCESSING

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Abstract: The article presents the results of evaluating the quality of food and vegetable soybean seed varieties intended for processing under the conditions of the Samarkand region in 2023–2025. Seed quality was assessed based on thousand seed weight, moisture content, batch uniformity (CV), and overall technological evaluation. The results showed that food soybean varieties have higher technological suitability for processing.

Key words: soybean seeds, processing, thousand seed weight, uniformity, coefficient of variation, technological evaluation

Introduction

Soybean (*Glycine max* (L.) Merr.) seeds are one of the main raw materials for processing in the food industry, and their technological suitability is primarily determined by the stability of seed quality indicators [1; 3; 5]. In processing practice, the stability of raw materials refers to the seed moisture regime, fractional uniformity, seed mass, physiological condition during storage, and compliance with standard industrial operations. Therefore, scientifically substantiating the factors affecting soybean seed quality, correctly selecting evaluation indicators, and conducting their comparative analysis under local conditions are of great importance for improving processing efficiency.

Generally accepted criteria and laboratory approaches for evaluating seed quality are primarily based on internationally standardized regulations. For example, the rules of the International Seed Testing Association (ISTA) emphasize the importance of comparative analysis of seed moisture, purity, thousand-seed weight, uniformity (fractional stability), and the results of standard laboratory tests when assessing seed quality. The main advantage of the ISTA approach lies in its ability to harmonize results obtained from different regions within a unified methodological framework, ensuring reliable comparison of raw material quality. From this perspective, the selection of standard indicators (seed mass, moisture content, and uniformity) for evaluating soybean seeds intended for processing is scientifically justified.

In addition, FAO (Food and Agriculture Organization) materials highlight the importance of regulating moisture content and ensuring batch uniformity in the storage and preparation system of cereal and legume raw materials. When the moisture regime is disrupted, not only is storage life reduced, but technological losses and fluctuations in product quality also increase during processing operations (grinding, extraction, thermal treatment, and others). The practical value of FAO sources lies in their interpretation of quality not merely as a laboratory parameter, but as a factor that must be managed throughout the entire supply chain—from field to processing facility. Consequently, when assessing seed quality under local conditions, it is necessary to consider the concept of “stable raw materials from the processing perspective.”

The literature provides extensive coverage of soybean processing technologies and technological requirements for raw materials. In particular, studies and methodological guidelines by Pugachev A.A., Dorovskikh V.A. [3], and related research emphasize that batch quality and uniformity are priorities in soybean processing, while indicators such as thousand-seed weight and moisture content significantly influence the selection of technological regimes in production. These sources underline the importance of measures such as batch sorting



(fractionation), moisture regulation, and proper organization of storage and pre-processing operations to form “standard raw materials.” From this standpoint, the stability of seed mass and batch uniformity in food-grade soybean varieties directly contributes to processing efficiency.

With the expansion of soybean cultivation in Uzbekistan, the use of varieties for different purposes—food and vegetable types—has also increased. Local studies emphasize the importance of adapting soybeans to agro-climatic conditions, selecting appropriate varieties, and conducting comparative assessments of raw material quality. It has been shown that in certain varieties, seed batch uniformity and mass may approach processing requirements [1; 4; 5]. The main advantage of local research lies in its analysis of raw material quality formed under Uzbekistan’s specific conditions (soil and climate, water availability, and agronomic practices) in direct connection with real production processes. Therefore, the simultaneous evaluation of food and vegetable soybean varieties and the identification of their differences from a processing perspective are of practical importance for local processing industries.

Overall, the key conclusion drawn from the reviewed sources is that the processing suitability of soybean seeds is determined not only by varietal characteristics, but also by technological indicators such as batch uniformity and moisture regime. Accordingly, comparative evaluation of these indicators in food and vegetable soybean varieties under local conditions serves as a scientific basis for targeted variety selection for processing purposes.

Research Methodology

In this study, the technological suitability of soybean seeds for processing was evaluated using **seed batch uniformity (homogeneity)** as the primary indicator. This choice is justified by the fact that stable raw material quality during processing, the accuracy of fractionation and dosing operations, and the consistency of technological regimes largely depend on the uniformity of the seed batch. As a methodological basis, the rules recommended by the **International Seed Testing Association (ISTA)** for the evaluation and statistical interpretation of seed batches were adopted.

The research was conducted during **2023–2025** at the “*Usmon dalalari*” farming enterprise in Bulungur district, Samarkand region, and at the scientific laboratory of the **Samarkand State University of Veterinary Medicine, Animal Husbandry and Biotechnology**. The objects of the study were seed batches of food-grade soybean varieties **Toyopro** and **Fora**, as well as vegetable soybean varieties **Ilkhom-6** and **Sulton-6**. For each variety, a working sample was prepared from the seed batch in accordance with ISTA requirements, and measurements were carried out under laboratory conditions with several replications.

To assess seed batch uniformity, the **thousand-seed weight (TSW)** was determined in multiple replications for each working sample corresponding to a given variety. Based on the obtained values, the degree of statistical variation within the batch was calculated. Uniformity was expressed using the **coefficient of variation (CV)**, calculated according to the following formula:

$$CV, \% = (S / \bar{X}) \times 100,$$

where S denotes the standard deviation and \bar{X} represents the mean value of the indicator. A lower coefficient of variation indicates higher seed batch homogeneity, which in turn reflects greater stability and technological suitability of the raw material during processing operations.

Research Results

The evaluation of the technological suitability of soybean seeds for processing was carried out in accordance with the selected methodology, based on four key technological indicators: **thousand-seed weight (TSW)**, **seed moisture content**, **seed batch uniformity (variation)**, and **overall technological assessment**. These indicators have a direct impact on raw material quality, the stability of technological regimes, and final product quality during processing operations.



In order to generalize the results and clearly identify differences among varieties, the indicators obtained during **2023–2025** were analyzed not on a year-by-year basis, but using **three-year average values**. This approach makes it possible to reduce the influence of annual variability, objectively assess varietal characteristics, and determine technological stability of raw materials intended for processing. Therefore, the technological suitability of soybean seeds was evaluated on the basis of three-year average values for the following key indicators: **thousand-seed weight**, **seed moisture content**, **seed batch uniformity (coefficient of variation)**, and **overall technological assessment** (see Table 1).

Table 1. Three-year average values of seed quality indicators in food and vegetable soybean varieties (2023–2025)

Variety	Type	Thousand-seed weight, g	Seed moisture, %	Uniformity (CV), %	Overall technological score, points
Toyopro	Food	165.2	12.7	4.3	4.9
Fora	Food	160.8	12.9	4.9	4.6
Ilkhom-6	Vegetable	148.6	13.5	7.8	3.8
Sulton-6	Vegetable	145.9	13.7	8.4	3.6

Results and Discussion

The three-year average results presented in Table 1 demonstrate clear and systematic differences in seed quality indicators between food-grade and vegetable soybean varieties. Regarding the first indicator—**thousand-seed weight (TSW)**—food-grade soybean varieties showed a clear advantage over vegetable soybean varieties. In particular, the Toyopro variety recorded a TSW of **165.2 g**, which was **19.3 g higher** than that of the Sulton-6 variety ($165.2 - 145.9 = 19.3$ g). Similarly, the Fora variety exceeded the Ilkhom-6 variety by **12.2 g** ($160.8 - 148.6 = 12.2$ g). This indicates that food-grade soybean varieties produce larger seeds, which are more convenient for dosing and technological operations during processing.

For the second indicator—**seed moisture content**—higher values were observed in vegetable soybean varieties. For example, the average moisture content of the Sulton-6 variety was **13.7%**, which is **1.0 percentage point higher** than that of the Toyopro variety (12.7%). Such differences in moisture content imply a potential need for additional drying or moisture regulation measures during processing.

The third indicator—**seed batch uniformity (CV, %)**—is of decisive importance from a processing perspective. Food-grade soybean varieties exhibited lower coefficients of variation, with **4.3%** for Toyopro and **4.9%** for Fora. In contrast, vegetable soybean varieties showed substantially higher variability, with **7.8%** for Ilkhom-6 and **8.4%** for Sulton-6. Thus, the internal dispersion of the seed batch in the Sulton-6 variety was **4.1 percentage points higher** than in the Toyopro variety, indicating the need for additional fractionation and preparation procedures prior to processing.

The fourth indicator—**overall technological assessment**—was determined based on the integrated interpretation of the above indicators. Among food-grade soybean varieties, Toyopro achieved the highest technological score (**4.9 points**), while Fora also fell into the high technological category with **4.6 points**. Vegetable soybean varieties, Ilkhom-6 (**3.8 points**) and Sulton-6 (**3.6 points**), were classified within the medium technological category. These results convincingly demonstrate, based on three-year average data, that food-grade soybean varieties are technologically more suitable for processing purposes.



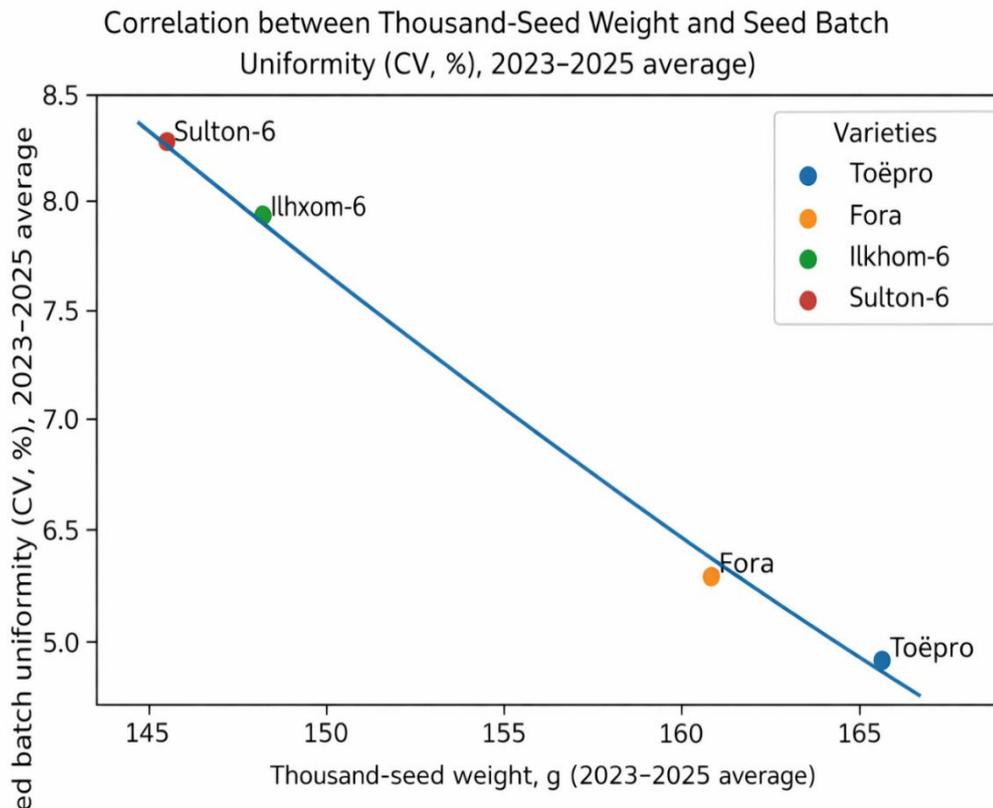


Figure 1. Correlation between thousand-seed weight and seed batch uniformity (CV, %, 2023–2025 average)

The graph shows a **very strong negative relationship** between thousand-seed weight and the coefficient of variation (CV, %). Based on the three-year average values of the four soybean varieties, the **Pearson correlation coefficient was $r = -0.997$** , indicating that as seed mass increases, the CV decreases and seed batch homogeneity improves markedly.

The linear regression equation was expressed as:

$$CV = 40.329 - 0.219 \times (\text{thousand-seed weight}),$$

with $R^2 = 0.995$, which means that approximately **99.5% of the variation in CV** is explained by changes in thousand-seed weight.

When comparing individual varieties, the **Toyopro** variety exhibited the highest thousand-seed weight (**165.2 g**) and the lowest CV (**4.3%**), indicating a highly homogeneous seed batch and strong suitability as a technologically stable raw material for processing. The **Fora** variety showed a slightly lower average seed mass (**160.8 g**) and a somewhat higher CV (**4.9%**), suggesting marginally greater internal variability compared with Toyopro.

In contrast, vegetable soybean varieties showed a clear increase in CV as seed mass decreased: **Ilkhom-6** (148.6 g; 7.8%) and **Sul-ton-6** (145.9 g; 8.4%). The higher internal dispersion of these seed batches indicates a greater need for additional preparatory operations (e.g., fractionation or homogenization) during processing. Thus, the graphical results quantitatively confirm that **thousand-seed weight is a key diagnostic indicator** for assessing seed batch uniformity

Conclusions

1. The results of studies conducted during **2023–2025** demonstrate that the processing suitability of soybean seeds is closely associated with **thousand-seed weight**. Food-grade soybean varieties exhibited higher values of this indicator, ensuring greater technological stability of the seed batches.



2. Seed batch uniformity (coefficient of variation) differed significantly between food-grade and vegetable soybean varieties. **Toyopro and Fora** showed low CV values, whereas **Ilkhom-6 and Sulton-6** exhibited higher internal variability, indicating the need for additional preparatory measures during processing.

3. Correlation analysis confirmed a **very strong negative relationship** between thousand-seed weight and seed batch uniformity, scientifically substantiating the use of thousand-seed weight as a **primary diagnostic criterion** for selecting soybean seeds intended for processing.

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