

# Study of safety and quality indicators of cereals and legumes in the southern part of Russia

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**Abstract.** The objects of the study were wheat, corn and soybean samples. We carried out studies to determine the quality indicators, as well as the content of grain impurities and insect infestation of the studied samples of the Krasnodar Territory and the Rostov Region. It was determined that the fiber content in the wheat is quite high. It was revealed that the content of pesticides and mycotoxins in wheat, corn and soybean crops are safe food raw materials. Harmful impurities were found in the crops, which indicates that the conditions for growing, processing, transporting and storing grain and leguminous crops are correct. Every safety index at the objects under investigation complies with the requirements of the regulatory documentation.

## 1 Introduction

Food grain farming is the strategic basis of the agro-industrial complex, as well as a multipurpose, backbone and multifunctional industry throughout the world [1]. That is why the indicators of quality and safety of the harvested grain are of key importance, which directly depends on the state control over its production and storage. The main regulatory documents for compliance with the quality safety of food grains and legumes are the Technical Regulations of the Customs Union "On Grain Safety", as well as GOST 9353-2016, GOST 13634-90 and GOST 17109-88 [2].

The provision of the population with quality food, economic and socio-political stability and the health of the nation as a whole largely depend on how the requirements for the safety and quality of grain are observed [3-4].

The quality of grain supplied to the market mainly depends on the manufacturer's compliance with the requirements of the current legislation, state control, which is mainly based on the requirements of the Technical Regulations of the Customs Union "On Grain Safety" to the processes of production, storage, transportation, sale and disposal of grain in order to protection of human life and health, the environment, life and health of animals and plants, as well as prevention of actions that mislead consumers [5-7].

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In the countries of the European Union, as well as the USA, Canada, state control is being strengthened, which encourages agricultural producers to provide the population with high-quality, and therefore safe for health, products. In Kazakhstan and Belarus, there are national systems for monitoring the safety and quality of grain in the domestic market [8].

Today, the Russian Federation remains a country (among the largest grain producers) in which state control over the quality and safety of grain is at a low level [9-10].

The purpose of the study is to analyze the safety and quality indicators of grain crops on the example of corn, wheat and soy producers in the Krasnodar Territory and the Rostov region. Thus, the indicators of quality and safety of the harvested grain are, of key importance, which directly depends on the state control over its production and storage.

## **2 Materials and methods**

Experimental studies were carried out on the basis of the scientific laboratory of biotechnology of the FGBOU VO "Astrakhan State University" and the branch of the FGBU "Russian Agricultural Center" in the Astrakhan region.

The objects of the study were: wheat samples, in bulk (Rostov region, Azov district, Novomargaritovo village) - harvest 2021; wheat samples, in bulk (Rostov region, Remontnensky district, Tikhyy Liman village) - harvest 2021; corn samples, in bulk (Krasnodar Territory, Kavkazsky District, Stepnoy village) - harvest 2021; corn samples, in bulk (Rostov region, Kasharsky district, Verkhnemakeevka settlement); soybean samples, in bulk (Rostov region, Rostov-on-Don) - harvest 2021; soybean samples, in bulk (Krasnodar Territory, Bryukhovetskaya station) - harvest 2021. Sampling was carried out in the amount of 2 kg: wheat and corn according to State Standard 13586.3-2015; soybeans - according to GOST 10852-86.

Organoleptic (type, subtype, condition, colour, smell), as well as physicochemical indicators of wheat quality, were determined according to GOST 9353-2016. Organoleptic (type, subtype, condition, colour, smell), as well as physicochemical indicators of corn quality, were determined according to GOST 13634-90. Organoleptic (condition, colour, smell), as well as physicochemical quality indicators (moisture and impurities) of soybeans were determined according to GOST 17109-88.

The quality indicators of wheat and corn for toxic elements, pesticides, mycotoxins, harmful impurities, as well as pest infestation were determined according to the regulatory documentation presented in Table 1.

Soybean quality indicators for toxic elements, pesticides, mycotoxins, and harmful impurities were determined according to the regulatory documentation presented in Table 2.

Pest infestation in wheat and corn was determined according to GOST 13586.6-93, and in soybean according to GOST 10853-88. Pest infestation in crops is not allowed.

Contamination with dead pests in wheat and corn, according to regulatory documents, is allowed no more than 15 ind./kg.

The results were processed by standard generally accepted methods. The scatter of data in the experiments was estimated by calculating the mean values and the standard deviation to identify the confidence interval at the 95% significance level. The Excel program was used for calculations.

**Table 1.** Standardized values of wheat and corn quality indicators according to regulatory documentation.

Indicator name	Normalized value for wheat, detection limit	Normalized Value for corn, detection limit	Regulatory documents for test methods
<i>Toxic elements:</i>			
lead, mg/kg	0.5	0.5	GOST 33824-2016
cadmium, mg/kg	0.1	0.1	GOST 33824-2016
mercury, mg/kg	0.03	0.03	GOST 26927-86
arsenic, mg/kg	0.2	0.2	GOST 26930-86
<i>Pesticides:</i>			
2,4-D acid, its salts, esters, mg/kg	Not permitted	Not permitted	ST RK 2010-2010
Mercury organic pesticides, mg/kg	Not permitted	Not permitted	ST RK 2040-2010
Hexachlorobenzene, mg/kg	0.01	-	GOST 13496.20-2014
Hexachlorocyclohexane (alpha, beta, gamma isomers), mg/kg	0.5	0.2	GOST 13496.20-2014
Dichlorodiphenyltrichloroethane and its metabolites, mg/kg	0.02	0.02	GOST 13496.20-2014
<i>Mycotoxins:</i>			
deoxynivalenol, mg/kg	0.7	-	ST RK 1988-2010
T-2 toxin, mg/kg	0.1	0.1	GOST 28001-88
zearalenone, mg/kg	1.0	1.0	GOST 31691-2012
<i>Pest infestation, ind./kg</i>	Not permitted	Not permitted	GOST 13586.6-93
<i>Contamination with dead insect pests, specimen/kg</i>	15	15	GOST 34165-2017
<i>Harmful impurities:</i>			
Ergot, %	0.05	-	GOST 30483-97
Ergot and smut, %	-	0.15	GOST 30483-97
Gorchak creeping, sophora foxtail, thermopsis lanceolate (in aggregate), %	Not permitted	Not permitted	GOST 30483-97
Vyazel multi-colored, %	0.1	0.1	GOST 30483-97
Heliotrope pubescent, %	0.1	Not permitted	GOST 30483-97
trichodesma hoary, %	Not permitted	Not permitted	GOST 30483-97
Smutty (stained, blue-headed) grains, %	10.0	-	GOST 30483-97
Fusarium grains, %	1.0	-	GOST 31646-2012
Presence of grains with bright yellow-green fluorescence, %	-	0.1	GOST 31646-2012

**Table 2.** Normalized values of toxicological indicators of soybean quality and harmful impurities according to regulatory documentation.

Indicator name	Normalized value, detection limit	Regulatory documents for test methods
<i>Toxic elements:</i>		
lead, mg/kg	1.0	GOST 33824-2016
cadmium, mg/kg	0.1	GOST 33824-2016
mercury, mg/kg	0.05	GOST 26927-86
arsenic, mg/kg	0.3	GOST 26930-86
<i>Pest infestation, ind./kg</i>	Not permitted	GOST 10853-88
<i>Harmful impurity:</i>		
castor seeds, %	Not permitted	GOST 10854-2015
<i>Pesticides:</i>		
Hexachlorocyclohexane (alpha, beta, gamma isomers), mg/kg	0.2	GOST 13496.20-2014
Dichlorodiphenyltrichloroethane and its metabolites, mg/kg	0.05	GOST 13496.20-2014

### 3 Results and Discussion

The results of studies of organoleptic quality indicators of wheat, corn and soybeans are presented in Table 3. The results of the tests showed that crops of wheat, corn and soybeans meet the requirements of regulatory documentation for all indicators: condition, colour, smell. Wheat and corn belong to type V. Wheat and corn have a healthy, non-heating state, with a color characteristic of healthy grain of this type, without moldy, malty, musty, and other smells. The results of studies of physical and chemical indicators of wheat quality are presented in Table 4.

**Table 3.** Organoleptic indicators of wheat, corn and soybean quality (actual and normalized values).

Indicator name	Actual value		Normalized value, detection limit
<i>Wheat</i>			
Region	Rostov region, Azov district	Rostov region, Remontnensky district	
Type, subtype	V Type	V Type	I, III, IV types, all subtypes; V type and mixture of types
State	Meet the requirements	Meet the requirements	In a healthy, unheated condition
Colour	Meet the requirements	Meet the requirements	Peculiar to a healthy grain of this type and subtype - Any degree of discoloration and darkening is allowed
Smell	Meet the requirements	Meet the requirements	Peculiar to healthy wheat grain, without moldy, malty, musty and other foreign smells
<i>Corn</i>			
Region	Krasnodar region, Caucasus region	Rostov region, Kasharsky district	
Type, subtype	V Type	V Type	I-IX, mixed types allowed
State	Meet the requirements	Meet the requirements	In a healthy unheated state
Colour	Meet the requirements	Meet the requirements	Normal color characteristic of a healthy grain, characteristic of this type
Smell	Meet the requirements	Meet the requirements	Normal smell (no musty, malty, moldy, foreign smells)
<i>Soybean</i>			
Region	Rostov region, Rostov-on-Don	Rostov region, Kasharsky district	
State	Meet the requirements	Meet the requirements	In a healthy unheated state
Colour	Meet the requirements	Meet the requirements	Peculiar to normal soybean seeds
Smell	Meet the requirements	Meet the requirements	Peculiar to normal soybean seeds, without musty, moldy and foreign odors

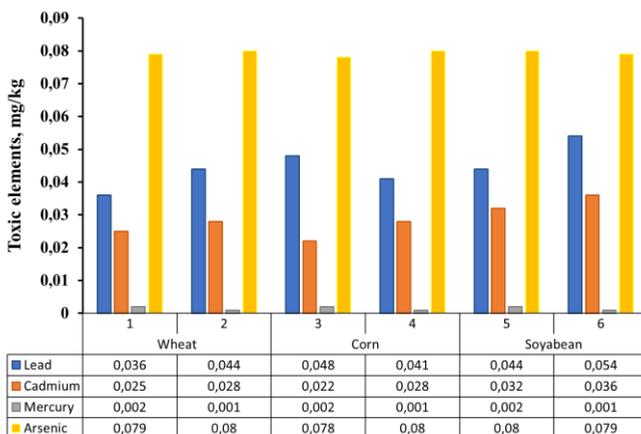
**Table 4.** Physical and chemical indicators of wheat quality.

Indicator name	Actual value	
	Azov district	Remontnensky district
Amount of gluten, %	28.2	27.4
The quality of gluten is not lower than group II, units. Index of gluten deformation	I, 71	I, 68
Falling number, s	267	283
Vitreousness, %	72.5	70.5
Nature, g/l	771	768
Humidity, %	12.2	12.4

Of the physicochemical parameters of corn, only moisture content (%) was determined, which is 16.1% for corn in the Krasnodar Territory, and 16.5% for corn in the Rostov Region. These values of indicators correspond to GOST 13634-90 (the norm for type V grain is 25.0%). Soybeans also have moisture. The value for soybeans in the Krasnodar Territory is 11.3%, for soybeans in the Rostov Region - 11.1%, which corresponds to the standard value (12.0%) GOST 17109-88.

According to the data in Table, it can be concluded that according to the physical and chemical parameters, the wheat harvested in the Rostov region of different regions corresponds to GOST 9353. The most important indicator of the quality of wheat is the fiber content. Its amount in the wheat of the Azov region is 28.2%, and Remontnensky region - 27.4%, which is quite high.

The gluten quality of the studied wheat samples is high. In the wheat of the Azov region, the value of the IDK is 71 and belongs to group I, and in the wheat of the Remontnensky region, the indicator is lower and amounts to 68 (group I). After determining the organoleptic and physico-chemical parameters, the studied samples of wheat, corn and soybeans were tested for toxic elements (lead, cadmium, mercury, arsenic), as well as pesticides and mycotoxins. The studies were carried out in the Testing Laboratory of the Rosselkhozcenter. The results of studies on the determination of heavy metals in crops are shown in Figure 1.



**Fig. 1.** Diagram of the content of heavy metals in samples of wheat, corn and soybean (1 - Rostov region, Azov district; 2 - Rostov region, Remontnensky district; 3 - Krasnodar Territory, Caucasian region; 4 - Rostov region, Kasharsky district; 5 - Rostov region, Rostov-on-Don; 6 - Krasnodar Territory, art. Bryukhovetskaya).

The diagram (Figure 1) shows that the lead content in soybean samples from the Krasnodar region is higher than in other crops and is 0.054 mg/kg. The content of cadmium in the soybean sample of the Krasnodar region is also high compared to other samples and is 0.036 mg/kg. The content of arsenic in all samples is minimal and is less than 0.08 mg/kg (the normalized value for wheat and corn is 0.2 mg/kg, and for soybeans - 0.3 mg/kg). The content of mercury in all samples is insignificant. The results of studies on the content of pesticides and mycotoxins in wheat, corn and soy showed that cereals and legumes are safe food raw materials. All safety indicators in the objects under study comply with the requirements of regulatory documentation. The results of determining the content of harmful impurities, the content of weed and grain impurities as well as pest infestation and contamination with dead pests in wheat, corn and soybeans indicate that the objects under study meet the requirements of regulatory documentation and are safe food raw materials.

The content of grain impurities is higher in the corn of the Krasnodar Territory and is 3.9%, the low content is in the wheat of the Rostov region of the Azov region. Harmful impurities were found in the crops, which indicates that the conditions for growing, processing, transporting and storing grain and leguminous crops are correct.

## 4 Conclusion

Grain crops, as well as their processed products, are the main strategic product of the Russian Federation, which is a national treasure and determines the stable functioning of the agricultural market and the country's food security. Our studies have confirmed the high importance of assessing the quality and safety of grains and legumes - wheat, corn and soybeans. Thus, the improvement of food safety must be ensured by a combination of agrotechnical and biotechnological methods, with special attention to the possibilities of compensating the impact of harmful contaminants on the human and animal organisms.

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