

Determination of norms of natural waste raw materials of the sugar industry during storage in natural and climatic conditions of Kazakhstan

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ABSTRACT

In this study, an analysis of scientific and technical literature was conducted to determine the norms of natural waste of raw materials in the sugar industry and products of their processing during storage in the Republic of Kazakhstan. The analysis showed the absence of regulatory documentation in this direction, and the available documentation on the norms of natural waste of raw materials in the sugar industry and products of their processing during storage was approved more than 30 years ago, during the Soviet Union. The study showed the structure of the gross harvest of sugar beet in Kazakhstan, the stages of the production cycle of beet sugar production and the products in which standardized indicators will be determined, as well as standardized indicators for the products of sugar beet processing at each stage of the production cycle of beet sugar production. These studies showed a loss of sugar beet mass during storage. In addition, according to the results of the studies, it was revealed that average daily losses ranged from 0.07 to 1.28% of sugar beet mass during storage for 60 days. The average daily indicator is 0.592% by mass of stored beets.

Keywords: Sugar beet, Sugar beet pulp, Processing of sugar beet.

Article type: Research Article.

INTRODUCTION

Sugar is a valuable nutritional product, one of the sources of poly-, di- and monosaccharides, helps to preserve and quickly restore human performance during physical and mental work. Therefore, this product plays a particularly important role in human nutrition. Sugar is a plant source and is extracted from plants. Plants have a variety of sugars that can be a source of sweetener (Goudarzi *et al.* 2015; Keykhosravi *et al.* 2017; Rahman *et al.* 2022; Mandil *et al.* 2023). At the same time, the low price of sugar compared to protein-containing products determines its economic advantage. According to experts, about 167 million are produced in the world. Tons of sugar, and there is a steady increase in the production of cane sugar, the share of which has reached 80%, with a gradual decrease in the specific weight of beet sugar, which is no more than 20% of the total level of production of this product (Gopikrishnan *et al.* 2022). However, sugar beet, according to many experts, has a much greater potential, both from the point of view of production of refined sugar from 1 ha of crops, and from the macroeconomic task of effective diversification of production (Apasov *et al.* 2012). The priority national projects of Kazakhstan include the development of the agro-industrial complex, the basic industry of which is the beet sugar industry, which forms the supply of raw materials for the food industry (Pashkov 2022). In the Republic of Kazakhstan, the main source of raw materials for the production of sugar is sugar beet, and according to statistical data, the beet-growing regions according to the indicator "Gross raw material yield in natural terms" are Almaty region 331.1 thousand tons, Zhambyl region 133.5 thousand tons, and Pavlodar region 1.6 thousand tons (Fig. 1).

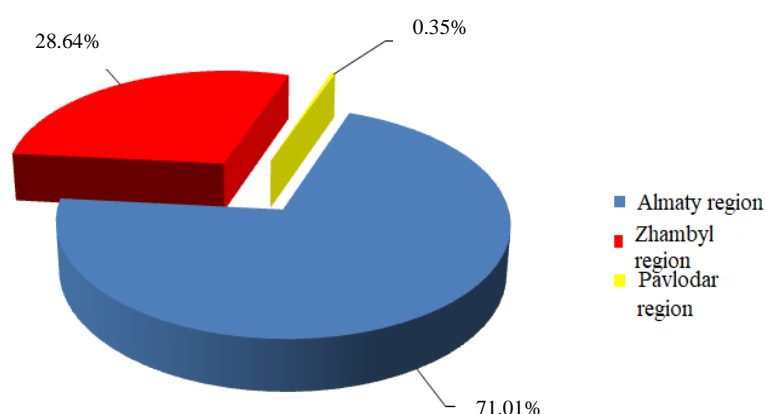


Fig. 1. The structure of the gross harvest of sugar beet in Kazakhstan (BNSASP 2021).

In total, according to 2021, four factories in Zhambyl region (Merkeny for sugar beet, Tarazsky for raw) and Almaty region for sugar beet (Koksusky and Aksusky) were operating in Kazakhstan. One of the reasons that negatively affect the activity of the beet sugar industry in Kazakhstan is the weak regulatory and technical base of the beet sugar industry.

1) The analysis of scientific and technical literature on determining the norms of natural waste of raw materials of the sugar industry and products of their processing during storage in the Republic of Kazakhstan showed the absence of normative documentation in this direction. In addition, the available documentation on the norms of natural waste of raw materials of the sugar industry and products of their processing during storage was approved by more than 30 years ago, during the Soviet Union:

2) Norms of natural loss of sugar-raw, sugar-sand, sugar-refined and powdered sugar during storage at enterprises of the sugar industry Approved by Decree of the Cabinet of Ministers of the USSR dated 26.06.1981 N 59 "On approval of the norm of natural loss of sugar-raw, sugar-sand, sugar - in the refinery and during storage of sugar powder at the enterprises of the sugar industry";

3) DNTD 03-91 Departmental norms of technological design of beet sugar factories Volume I (Introduction date 1992-01-01) introduced by the Giprosakhprom Institute Approved by the Head of Agricultural Research Projects of the Ministry of Agriculture and Food of the USSR 09.09.91 (letter N 070-81/318) WITH "Departmental norms of technological design" beet sugar factories" DNTD 03-85.

In this regard, the development of regulatory documents for determining the norms of natural waste raw materials of the sugar industry and products of their processing during storage is relevant and in demand (VNTP, 1992; Tahmasbi *et al.* 2019; Loginov *et al.* 2021).

To develop a methodology for determining the norms of natural waste of raw materials of the sugar industry and products of their processing during storage, based on the analysis of the technological process of beet sugar production, the products (Fig. 2) and normalized indicators for the products of sugar beet processing at each stage of the production cycle of beet sugar production, taking into account their aggregate state (Tables 1-2).

Table 1. Aggregate state of products of beet sugar production.

Object of research	Processes that cause natural decay	Aggregate state
Sugar beet	respiration, germination, suberenization	firmly
Sugar-sand	decrease in humidity during storage, spray, mold	firmly
bagasse	loss of moisture during storage, decay, microbiological processes	firmly
Molasses	moisture loss during storage, razmaz	liquid

Thus, to determine the norms of natural loss of raw materials of the sugar industry and products of their processing during storage, the following normalized indicators are defined: for sugar beet: natural loss mass, loss during transportation, loss from spoilage; for sugar sand: drying, shaking, loss during transportation; for beet pulp: natural waste mass, loss from spoilage; for molasses: natural loss, loss during transportation. Two climatic zones are also defined, which will be taken into account during the development of norms for the storage of natural waste raw materials of the sugar industry and products of their processing (BNSASP, 2021). The purpose of the study is to

assess the natural waste of raw materials of the sugar industry during storage in the natural and climatic conditions of Kazakhstan. The novelty of the research is the obtained information on the mass loss of sugar beet in the conditions of the Almaty and Zhambyl regions.

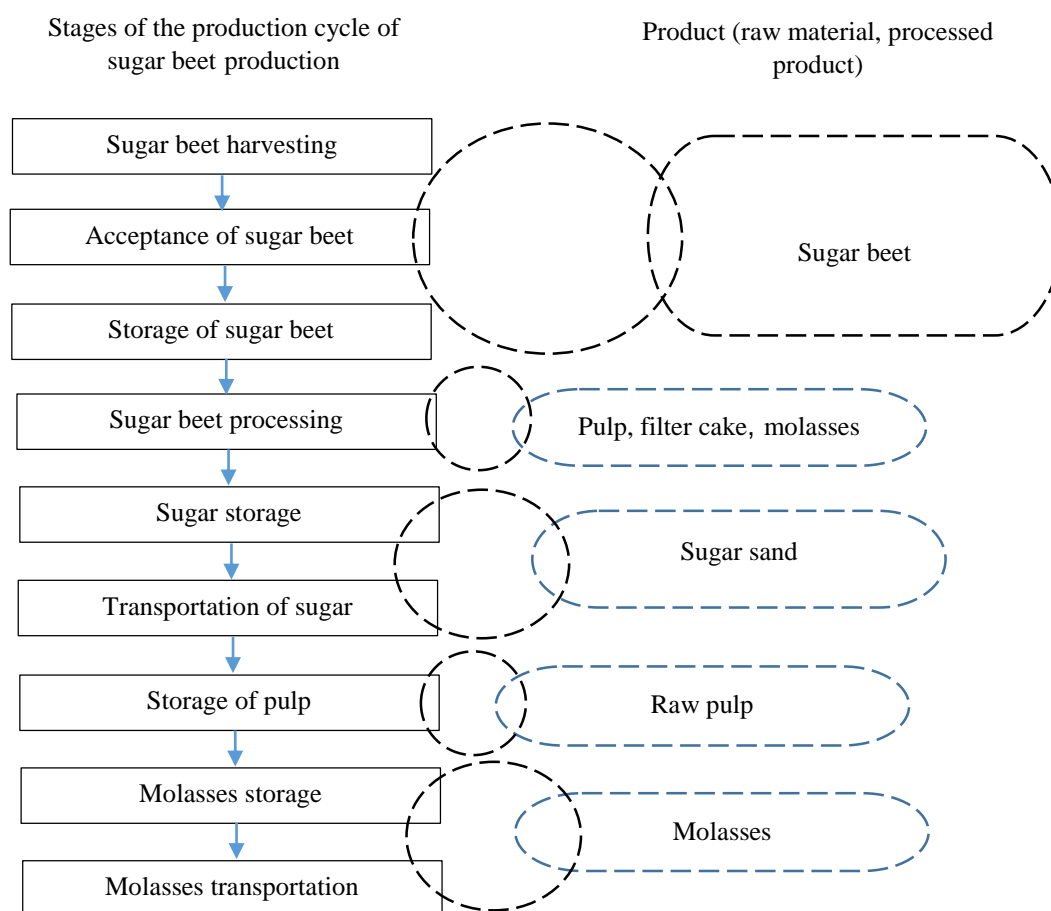


Fig. 2. Stages of the production cycle of beet sugar production and products in which standardized indicators will be determined.

Table 2. Normative indicators for sugar beet processing products at each stage of the production cycle of beet sugar production.

№	Name of the stage of the production cycle of beet sugar production	Name of the product (raw material, product processing)	Normalized indicator
1	Harvesting sugar beets	sugar beet	loss during transportation, loss from spoilage
2	Sugar beet storage	sugar beet	natural decay, loss during transportation
3	Sugar storage	Sugar-sand	usushka, utryaska
4	Transportation of Sahara	Sugar-sand	shock, loss during transportation
5	Storage is good	bagasse	natural ubul
6	Storage molasses	molasses	natural ubul
7	Transportation of molasses	molasses	loss during transportation

MATERIALS AND METHODS

In order to determine the loss of beet mass, research was carried out using a grid with samples of root crops weighing 6-10 kg each, stored in boxes at sugar beet processing enterprises in Zhambyl and Almaty regions and on the basis of PSHOS in Pavlodar region. Control grids were laid at the rate of 1 grid per 300-500 ton of stored beets, however, at least 6 grids in one section of the kagata according to the scheme (Fig. 1).

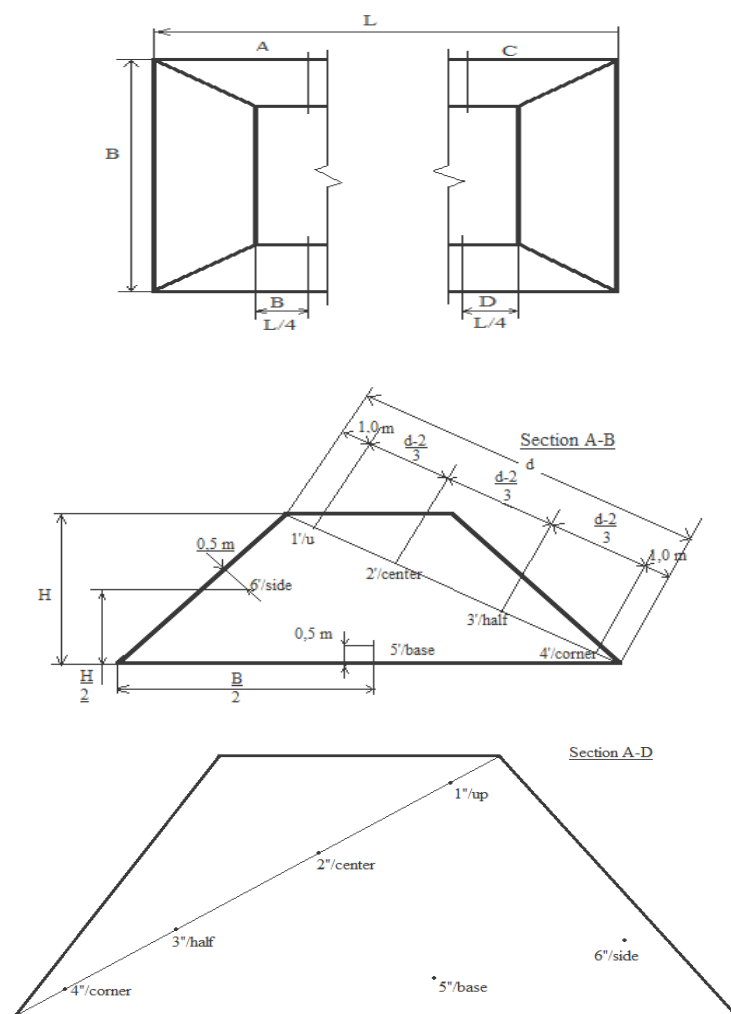


Fig. 3. Scheme of laying grid samples in a pile.

To form grid samples of root crops in each section, it is necessary to select one large average sample of beets at a different height. From this sample, make 8 homogeneous samples, put 6 of them in grids, and send 2 to the raw material laboratory for analysis. The paper capacity is 2 thousand tons should be laid grid samples of root crops in one section, in the middle of a row, in a row from 2 to 4 thousand tons in two sections. A label is attached to each net with the following information: date of planting sample, quantity of root crops, mass of root crops in the net, number of the net and number of the sheet. The change in the weight of beets after tapping is determined as the arithmetic mean of all grid samples of root crops. The loss of beet mass and sugar during storage of beets is calculated after the end of the collection of leaves and the extraction of all nets according to the following formula:

$$P_2 = \frac{P_1 (100 - P)}{100}$$

where P_2 is the mass of beets at the fence, etc.; P_1 is the mass of beets when laying, etc.; P - loss of mass of beets according to grid samples (%).

By dividing the indicator of loss of beet mass and sugar, %, by the duration of storage in days, half of the average daily loss, % by the mass of beet placed in storage.

RESULTS AND DISCUSSION

The results of studies on the loss of sugar beet mass during storage are presented in Table 4.

Table 4. Mass of lost sugar beets when stored in paper bags.

Quantity of roots in a net (pieces)	Mass of net initial (kg)	The mass of the net is final (kg)	Shelf life (days)	Mass loss during the storage period (kg)	Storage period (%)	Average daily weight loss during storage (%)	Deviation from the average daily value of lost weight during storage
up to 15 days							
14	14.635	13.51	6	1.13	7.687	1.28118	-1.052291004
13	14.615	13.52	6	1.10	7.492	1.24872	-0.95937411
9	7.28	6.95	14	0.33	4.533	0.32378	-0.147933418
6	6.37	6.195	14	0.18	2.747	0.19623	-0.036679088
6	7.2	6.99	14	0.21	2.917	0.20833	-0.089582136
6	7.85	7.77	14	0.08	1.019	0.07279	0.075889644
6	7.405	7.17	14	0.24	3.174	0.22668	0.22786464
6	7.475	7.29	14	0.19	2.475	0.17678	-0.055026495
Average for 15 days					3.204	0.22888	
up to 30 days							
8	8.49	7.925	23	0.57	6.655	0.28934	-0.088370525
8	8.53	8.185	23	0.34	4.045	0.17585	-0.103922049
8	8.175	7.875	23	0.30	3.670	0.15955	-0.202688376
6	5.675	5.52	23	0.16	2.731	0.11875	-0.009720243
14	10.7	10.35	22	0.35	3.27103	0.14868	-0.102741852
13	9	8.1	22	0.9	10	0.45455	-0.328388471
14	11.2	10.9	22	0.3	2.67857	0.12175	0.04227794
14	12.8	12.4	22	0.4	3.125	0.14205	-0.000390235
Average for 30 days					4.52188	0.20097	
up to 60 days							
13	14.71	13.745	52	0.97	6.560	0.12616	0.133025
15	14.01	12.815	52	1.20	8.530	0.16403	0.095151
14	13.44	12.45	52	0.99	7.366	0.14166	0.117527
12	12.82	11.77	52	1.05	8.190	0.15751	0.101676
14	13.97	12.85	52	1.12	8.017	0.15418	0.105005
15	14.55	12.96	52	1.59	10.928	0.21015	0.049031
16	14.28	12.885	52	1.40	9.769	0.18786	0.071318
14	14.04	13.34	52	0.70	4.986	0.09588	0.163302
14	13.76	12.61	52	1.15	8.358	0.16072	0.09846
15	12.5	11.74	52	0.76	6.080	0.11692	0.142259
Average for 60 days					7.878	0.15151	
Total average daily weight loss of sugar beet during storage for the entire storage period						0.59195	

During the experiment, the weather and climatic conditions of storage were fixed (Fig. 4).

According to the International Sugar Organization, the most important factors influencing the demand for sugar are:

- population growth,
- income per capita,
- price of sugar and alternative sweeteners,
- discussion problem is health.

Sugarcane crops offer a productive alternative to food products, such as livestock feed, fiber and energy, especially biofuels (sugar-based ethanol) and cogeneration electricity (dry sugar cane). Sugar cane is usually considered one of the most important and effective sources of biomass for biofuel production

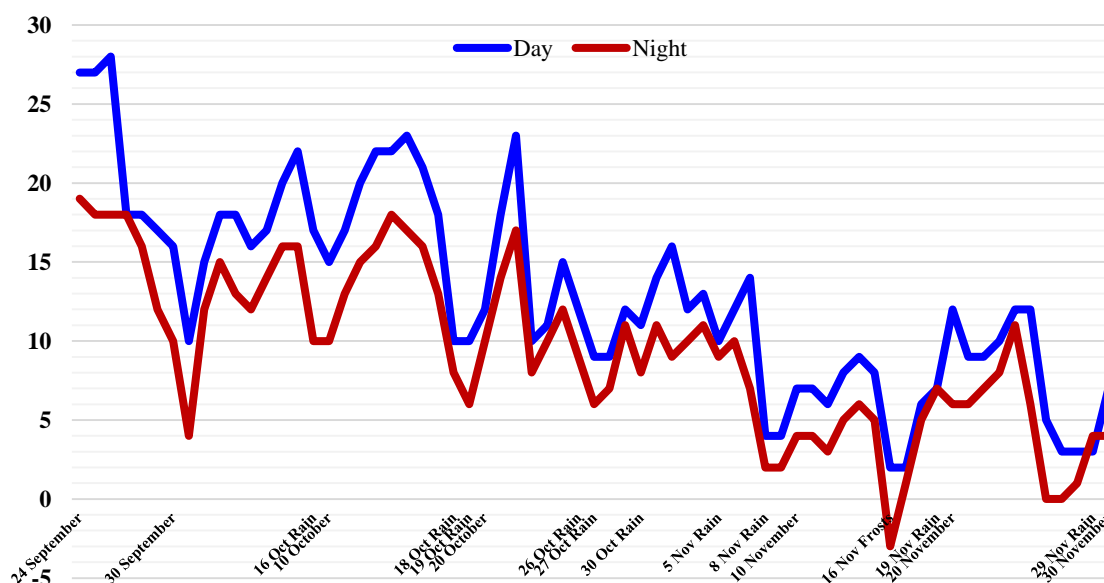


Fig. 4. Temperature chart in Merke district from September 24 to November 30, 2022.

Short-term precipitation in the form of rain on November 19, after frosts on November 16, occurred during the harvesting period of sugar beets, which complicates the operation of harvesting equipment, and also increases the general contamination of root crops. For this region, the dynamics of temperature changes in the autumn period is characterized by the influence of cyclones from the northwest. Taking into account the abnormal heat and the small amount of precipitation in the summer of 2021, the fertile layer of the soil did not absorb enough moisture, and the precipitation in the winter period also did not provide arable land with water. Merkensky district is located in the foothills of Alatau, on the peaks of which snow falls, which ensures the filling of small rivers and streams in the spring and summer periods, and depending on the air temperature, they can dry up quickly. Natural and climatic conditions of the Zhambyl region are characterized by the following indicators (RGP, 2002).

- The maximum air temperature in summer is +45-48 °C, the average is 21-25 °C, the maximum is -40-45 °C in winter, the average is 8-12 °C.

- Average annual precipitation is 140-330 mm per year.

- The peculiarity of the climate is considerable aridity and continentality.

Frosts on November 16 and precipitation on November 19, which came with an extensive north-western cold cyclone to the entire territory of southern and southeastern Kazakhstan, affected the harvesting campaign not only of sugar beets, but also of other crops whose vegetation period falls on these days.

The variety of climatic features is due to the fact that the northern part of the region is a plain with ridge and dune sands, and the southern part is cut by mountain ridges with a characteristic change of vertical belts. The main natural and climatic characteristics of the region are reflected below (RGP 2002):

- The maximum air temperature in summer is +40 °C, the average is 25-26 °C, the maximum is 30 °C in winter, the average is 11-13 °C.

- Average annual precipitation is 125-900 mm per year.

- A feature of the climate is continental, large daily and annual fluctuations in air temperature.

CONCLUSION

Experimental data on the determination of indicators of natural loss of raw materials of the sugar industry during storage in the natural and climatic conditions of Kazakhstan showed that average daily losses range from 0.07 to 1.28% by weight of beets during storage for 60 days. The average daily indicator is 0.592% by mass of stored beets.

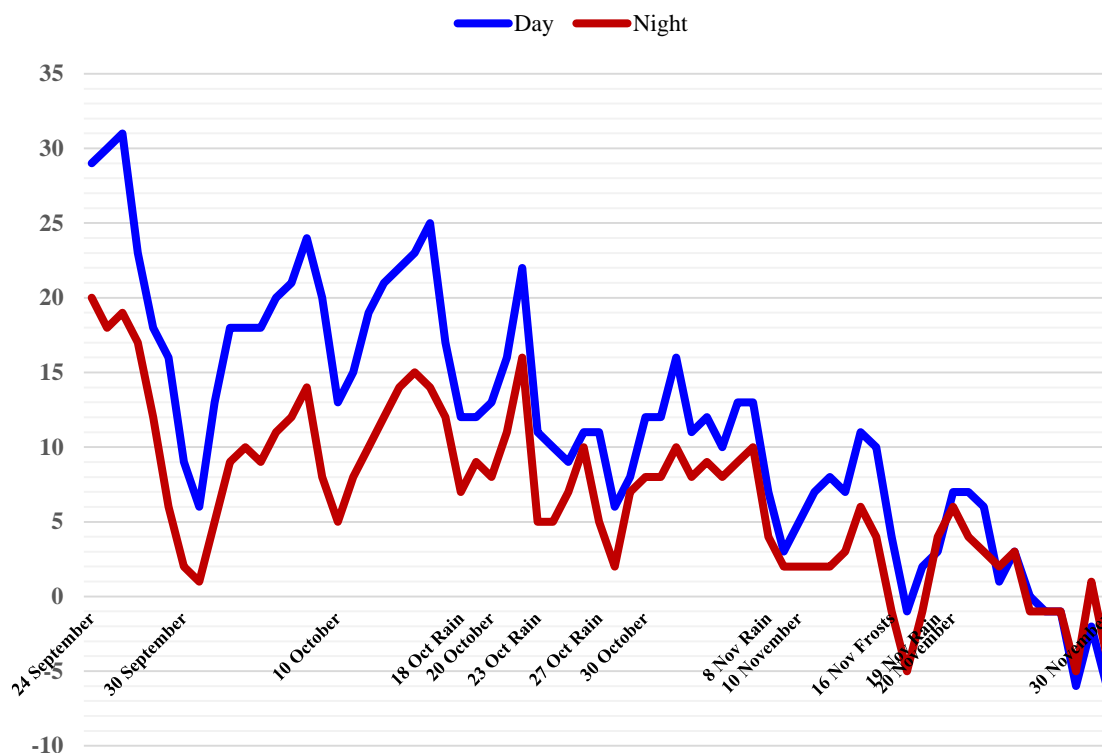


Fig. 5. Temperature chart in Taldyqorgan district from September 24 to November 30, 2022.

ACKNOWLEDGMENT

The work was carried out within the framework of program-targeted financing of the Ministry of Agriculture of the Republic of Kazakhstan for 2021-2023. IRN - BR10764977.

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Bibliographic information of this paper for citing:

Dautkanova, D, Dautkanov, N, Kazhymurat, A, Mukasheva, M 2024, Determination of norms of natural waste raw materials of the sugar industry during storage in natural and climatic conditions of Kazakhstan, *Caspian Journal of Environmental Sciences*, 22: 689-696.