Study of the influence of processing methods on the commercial quality and the amount of losses of cauliflower during storage

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Abstract. During the harvesting period, no more than 50% of the harvested vegetables can be processed or consumed fresh. The aim of the study was to study the effect of treatment with extremely low frequency electromagnetic fields (ELF EMF), the use of an antimicrobial agent (natamycin) and packaging in polymer films, on the amount of loss of cauliflower during storage. It was found that the most effective treatment is with an aqueous solution of natamycin and subsequent treatment with ELF EMF, which allowed the maximum increase in the outcome of standard products by 12.5 %. The concentration of 0.09 g/l was chosen as the optimal concentration of the natamycin solution. The smallest losses in the storage process were shown by samples subjected to preliminary complex processing, stripped from covering green leaves, packed in a food plastic film. The output of standard products increased by 13.1 % compared to the control samples.

1 Introduction

Cauliflower belongs to the group of vegetable juicy raw materials. It is distinguished by a number of features of the course of physiological and biochemical processes due to high humidity, which increases the intensity of metabolism in cells. This fact makes it difficult to organize the storage of such raw materials: the quality quickly decreases, losses increase, which are affected by relative humidity, temperature, degree of aeration, variety, degree of maturity of raw materials, the presence of mechanical and other damage, infection with phytopathogens.

Concerned consumers about possible residual amounts of chemicals and resistance of pathogens to chemicals justified the need to develop new methods to ensure the safety of crop products [1, 2]. These methods include some types of physical effects (ultraviolet radiation, ultrasound, low pressure, pulsed light, electromagnetic fields) and biological effects (biological products). In our previous studies, the stability of plant raw materials

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during storage was increased by processing with extremely low frequency electromagnetic fields [3-14]. The advantage of physical treatment is that it acts directly on pathogenic microorganisms on the surface of objects, without contaminating the objects themselves. But there is also information that physical and biological treatments cause changes in plant production tissues, such as increased resistance to abiotic and biotic stress. This may be accompanied by changes in the commercial quality of products [1, 15].

In this regard, it is of interest to study the effect of processing cabbage vegetables with extremely low frequency electromagnetic fields (EMF ELF) and preparations of native biological reagents on stability during storage. The revealed regularities will allow us to develop new methods of preparation for storage of vegetable juicy raw materials.

2 Materials and methods

The object of the study was cauliflower of the highest commercial grade Bering F1.

To determine the effect of natamycin concentration on the stability of cauliflower during storage (t=+10±1 °C, W=85±3 %, T=28 days), the samples were treated with an aqueous solution of natamycin (0.03, 0.06, 0, 09, 0.12 g/l).

To determine the effect of the pretreatment method on commercial quality and loss from natural attrition, the test samples were treated with an aqueous solution of natamycin (0.09 g/l); exposed to electromagnetic waves of ELF (25 Hz, 10 mT, 30 min); complex treatment was used (natamycin solution+EMF ELF).

To determine the effect of packaging materials and the type of processing of raw materials on the output of standard products and the amount of loss of cauliflower during storage (t=+10±1 °C, W=85±3 %, T=28 days), samples with and without covering green leaves were used. The processing of the studied samples was carried out using the methods described above. Food-grade polyethylene film (300 μm) was used as a packaging material.

Original samples were not processed.

ELF EMF processing was carried out using a laboratory experimental setup consisting of a RIGOL DG1022 universal signal generator, an MMF LV102 amplifier, a LeCroy WA202 oscilloscope, and a solenoid (length 802 mm, diameter 204 mm, 533 turns per row). The plant material was placed in a solenoid and exposed to electromagnetic oscillations with a set frequency and induction.

3 Results and discussion

At the first stage of the study, the optimal concentration of an aqueous solution of natamycin was selected for the purpose of further complex processing with EMF ELF. The results of the study of the effect of various concentrations (0.03, 0.06, 0.09, 0.12 g/l) of natamycin on the loss of cauliflower during storage are presented in Table 1.

Table 1. The amount of loss of cauliflower during storage depending on the concentration of natamycin

Processing method	Indicators, %		
	output of standard products	absolute waste and rot	normal wastage
Original sample	79.4±2.4	10.7±0.4	9.9±0.4
Aqueous solution of natamycin (0.03 g/l)	82.1±1.2	9.6±0.1	8.3±0.3
Aqueous solution of natamycin (0.06 g/l)	84.3±0.1	7.8±0.2	7.9±0.3

Aqueous solution of natamycin (0.09 g/l)	89.4±1.2	5.6±2.4	5±0.2
Aqueous solution of natamycin (0.12 g/l)	89.4±1.2	5.6±2.4	5±0.4

It was found that the treatment of cauliflower with an aqueous solution of natamycin before storage for 28 days reduces losses compared to control samples by 2.7-10%, depending on the concentration of natamycin. Since the treatment with aqueous solutions with a concentration of natamycin of 0.09 g/l and 0.12 g/l did not change the magnitude of the natural loss, it was concluded that increasing the dosage is not advisable. For further studies, the concentration of natamycin was taken to be 0.09 g/l.

At the next stage of the study, various pre-treatment of cauliflower was carried out: with an aqueous solution of natamycin with a concentration of 0.09%, EMF ELF, complex treatment. The results are presented in table 2.

Table 2. The amount of loss of cauliflower during storage, depending on the processing method

Processing method	Indicators, %		
	output of standard products	absolute waste and rot	normal wastage
Original sample	79.4±2.4	10.7±0.4	9.9±0.4
EMF ELF processing	86.5±2.4	6.3±0.1	7.2±0.2
Aqueous solution of natamycin	89.4±1.2	5.6±2.4	5.0±0.2
Complex processing	91.9±3.2	3.8±0.3	4.3±0.3

In the course of the study, it was found that ELF EMF treatment made it possible to reduce losses by 7.1 % compared to control samples, treatment with an aqueous solution of natamycin made it possible to reduce losses by 10 %, and complex treatment made it possible to reduce natural losses by 12.5 %.

At the next stage, the influence of packaging materials (food film) and the type of preparation of raw materials (cleaning from covering green leaves, treatment with an aqueous solution of natamycin, ELF EMF treatment, complex processing) on the output of standard products and the amount of total losses of cauliflower during storage was studied (Figures 1-2).

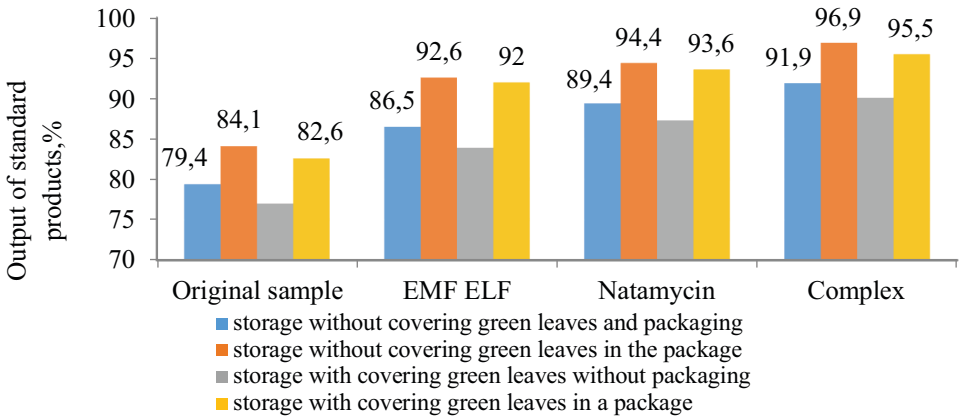

Fig. 1. Output of standard products depending on the methods of preparation for storage

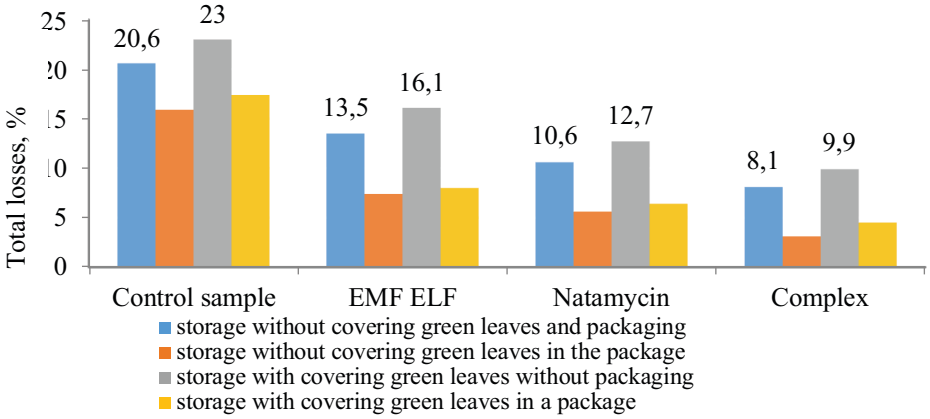

Fig. 2. Total losses of cauliflower depending on the methods of preparation for storage

The authors found:

- when storing cauliflower without covering green leaves and without packaging, treated with EMF ELF, the щгезге of standard products increases by 7.1 %, treated with an aqueous solution of natamycin – by 10 %, complex processing – by 12.5 %;
- when storing cauliflower without covering green leaves, packed in cling film, treated with EMF ELF, the output of standard products increases by 8.5 %, treated with an aqueous solution of natamycin – by 10.3 %, complex processing – by 12.8 %;
- when storing cauliflower with covering green leaves without packaging, treated with EMF ELF, the output of standard products increases by 6.9 %, treated with an aqueous solution of natamycin – by 10.3 %, complex processing – by 13.1 %;
- when storing cauliflower with covering green leaves, packed in food film, treated with EMF, ELF the output of standard products increases by 9.4 %, treated with an aqueous solution of natamycin – by 11 %, complex processing – by 12.9 %.

4 Conclusion

During the first stage of the study, it was found that the treatment of cauliflower before storage with an aqueous solution of natamycin reduces the amount of losses. The optimal concentration of the solution was determined – 0.09 g/l. Processing of cauliflower with a solution of this concentration was recommended for further complex processing.

In the process of studying the effect of various types of pre-treatment of cauliflower on the amount of losses due to rot and natural wastage, it was found that the most effective method is a complex treatment consisting of an aqueous solution of natamycin with a concentration of 0.09 g/l and EMF ELF treatment. Such preliminary complex processing of cauliflower allowed to maximize the output of standard products by 12.5 %.

A positive effect of packaging materials on reducing cauliflower losses during storage were also revealed. The smallest losses during storage were shown by the studied samples without covering green leaves, subjected to preliminary complex processing and packed in a food polyethylene film. The output of standard products compared to control samples increased by 13.1 %.

Thus, the use of storage preparation technology that combines the reduction of product contamination before storage by processing with EMF ELF and the slowdown of physiological processes due to the antagonistic properties of natamycin, as well as the removal of covering green leaves and packaging of cauliflower in polyethylene film, will increase the safety of cauliflower during storage.

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