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# The effect of long-term storage conditions on seed germination in vegetables and medicinal plants

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Seeds of six species of medicinal plants and four species of vegetables were subjected to ultra-desiccation and freeze storage for one year. During this period alterations in germination occurred. The viability declined significantly in the medicinal plants *Leonurus cardiaca* and *Salvia officinalis*. Germination in *Calendula officinalis* and *Lavandula angustifolia* improved because of dormancy break. *Carum carvi* accessions differed in their tolerance to these storage conditions. There were no negative alterations by 22% of caraway accessions. The rest of them lost viability in 10–50%. Cultivars of vegetables showed marked differences in their response to the long-term storage conditions on intra-species level.

**Key words:** long-term seed storage, vegetables, medicinal plants, ultra-desiccation, germination

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## INTRODUCTION

It is generally accepted that long-term conservation conditions (low water content in the seeds and their maintenance at sub-zero temperatures) prolongs the lifespan of seeds. However, the effect of extremely low water content on seed and a possible interaction of water content and temperature are disputed [1]. The potential benefit of ultra-drying and refrigerated storage to seed longevity has to be weighed against the potential risk of damaging seeds. Drying seeds to very low water contents may reduce longevity or cause genetic alterations [2–3]. The idea that there is an optimum water content for seed storage and that the values are likely to be dependent on species [4] rose the question – how ultra-drying and storage at low temperatures for one year affect seed germination.

The purpose of the present study was to determine whether drying seeds to a very low water content and keeping in refrigerators affected seed germination in vegetables and medicinal plants and how this effect differed among species.

## MATERIALS AND METHODS

Seeds of the vegetables *Cucumis sativus* L., *Beta vulgaris* L., *Lycopersicon esculentum* L., *Daucus carota* L., and of the medicinal plants *Carum carvi* L., *Calendula officinalis* L., *Leonurus cardiaca* L., *Rhaponticum carthamoides* Iljin., *Scutellaria baicalensis* Geor-

gi, *Lavandula angustifolia* Mill. were harvested in 1999. All seeds were dried from their initial water content for three months at 20 °C in the environment with a 10% relative humidity. After drying, seeds were packaged in foil-laminated bags and stored at –18 °C in the freezers for one year. Germination percentage was determined before and after the drying and freezing phases. Seeds were kept on a damp filter paper at 20 °C for 20–30 days. In order to avoid possible imbibitional injury, desiccated seeds were exposed to 70% RH at room temperature for 10 days. The difference of germination was counted before and after storage in the freezers for one year. Also the percentage of hard, fresh and dead seeds was determined among ungerminated seeds of caraway.

## RESULTS AND DISCUSSION

The purpose of these experiments was to estimate seed tolerance in different vegetables and medicinal plants to long-term storage conditions. Shortage of such information especially concerns medicinal plants. During this research work, seed samples of seven species were collected. Some of them had a high germination percentage before drying: *Leonurus cardiaca* – 88 ± 2%, *Rhaponticum carthamoides* – 89 ± 3%, *Scutellaria baicalensis* 78 ± 3%. However, in *Lavandula angustifolia* germination was just 13.7 ± 4%, *Calendula officinalis* – 41 ± 2%, *Salvia officinalis* – 64 ± 3%. After ultra-drying and freezing,

significant alterations of germination were registered (Fig. 1). In the experiment with medicinal plants the percentage of dormant seeds was not determined. But it is possible to make a premise that a significant increase of germinated seeds in *Calendula officinalis* and *Lavandula angustifolia* was caused by the break of dormancy. In *Leonurus cardiaca* and *Salvia officinalis*, final germination in comparison with initial was lower by 25–30%. However, these results are questionable, as they do not represent intraspecies variation.

*Carum carvi* L. is considered as a medicinal and culinary herb. Lithuanian University of Agriculture collects mostly wild caraway populations in different regions of the country and evaluates, characterizes them in trial fields. The best populations are stored in the genebank. Conservation of wild caraway seeds is problematic. During a year of storage of ultra-desiccated seeds in freezers, a significant reduction in germination was observed. In the large part of accessions the germination percentage was decreased by 20–50%. This could be explained by a low initial viability of seed samples (45–70%). During storage, seed lots with low viability lost their germination much faster than did seeds with high initial viability [5].

In order to determine the maximum germination potential of *Carum carvi*, seed lots were counted ungerminated, but fresh and hard. The ratio between germinated and dormant seeds ranged within 1.2–2.8 in a large number of accessions. This means that in most of accessions the dormancy reached 36 to 83%. Thus, even after one year of storage in freezers the seeds germinated very poorly.

Storage behaviour of traditional vegetables is well investigated and described by many authors on species level. However, a general statement for a whole species often is rough. Estimation of intraspecies variation revealed differences among accessions in their tolerance to the long-term storage conditions (Fig. 2). During the experiment just germinated seeds were counted. An obvious increase in germination of some seed lots can be explained by the break of dormancy. *Lycopersicon esculentum* accessions had a higher final than initial germination percentage. It had improved by nearly 20% in some of them. The average of initial germination in tomato seeds was 84% and the final 97% after a one-year storage in the freezers. *Daucus carota* accessions showed a large variability in their response long-term storage conditions. Few of them improved germination by 10–20%, in others it decreased by more than 40%.

A significant reduction in germination was observed in *Cucumis sativus*. No detrimental effect of ultradesiccation and freezing was detected by alterations in *Beta vulgaris* germination.

The limited amount of vegetable and medicinal plant seeds that is usually provided for the genebank does not allow constant control of water content during drying process. Thus, seed samples can be sometimes overdried. The interaction of water content, temperature, initial seed quality and even genotype results in a large variability of tolerance to the long-term storage conditions within a species. It is sometimes more significant than among different species. The results presented here suggest that it is problematic to establish optimal long-term storage conditions for individual species. Only a more frequent germination control can guarantee the survival of accessions stored in the genebank.

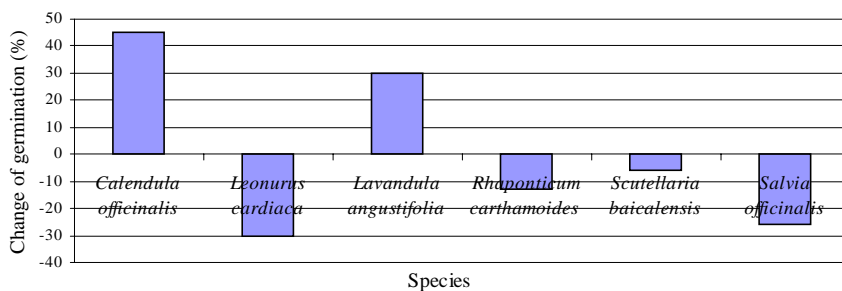


Fig. 1. Alteration of seed germination in some medicinal plants after one-year storage in long-term storage conditions

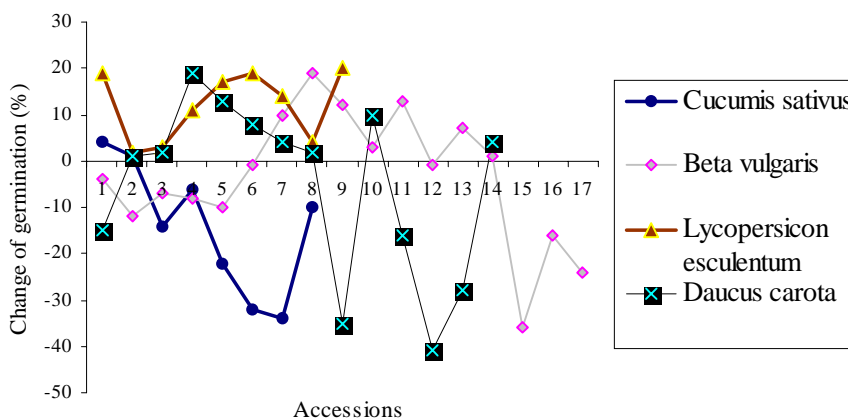


Fig. 2. Variation among vegetable accessions in their change of germination after one-year storage in long-term storage conditions

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### ILGALAIKIO SAUGOJIMO SĄLYGŲ ĮTAKA DARŽOVIŲ IR MEDICININIŲ AUGALŲ SĖKLŲ DAIGUMUI

#### S a n t r a u k a

Šešios vaistažolių ir keturios daržovių rūšių sėklos buvo ultradesikuojamos ir laikomos šaldikliuose vienerius metus. Stebėta, kaip tai paveiks sėklų daigumą. Iš tirtų vaistažolių sėklų *Leonurus cardiaca* ir *Salvia officinalis* gyvybingumas labiausiai nukentėjo. Tuo tarpu *Calendula officinalis* ir *Lavandula angustifolia* sėklų pavyzdžiai sudygo po desikacijos ir šaldymo net geriau nei buvo prieš tai dėl pabudimo iš ramybės periodo. *Carum carvi* įvairios populiacijos skirtingai reagavo į ilgalaikes saugojimo sąlygas. Kmynų tik 22% populiacijų daigumas nepablogėjo, o kitų sumažėjo net 10–15%. Tirtų daržovių rūšių veislės taip pat ryškiai išsiskyrė pagal savo tolerantiškumą utradesikacijai ir šaldymui vidurūšiniame lygmenyje.