DENDROBIOLOGY
2002, vol. 47, Supplement: 33–38

*Anna Gugała*

# Changes in quality of beech (*Fagus sylvatica* L.) seeds stored at the Forest Gene Bank Kostrzyca

**Abstract:** In the Forest Gene Bank cold stores, both long-term and strategic gene resources are stored to be used during periods of poor seed production. Beech seeds of the following harvests were evaluated: 1995, 1998 and 2000. Quality of seeds was determined with different methods from the date of reception to FGB through preparation for long-term storage, storage in cold stores and the presowing treatment. The usefulness of staining tests for rapid evaluation of beech seed viability is not sufficiently sure. The floating test in water significantly improves the level of seed purity. The current method of seed drying does not remain without influence upon beech seeds and causes a slight decrease of viability. Next to beech seed lots of rapidly declining quality in the FGB are stored seed lots whose viability does not decrease during identical technological processes. Seed lots of low initial viability should be eliminated.

**Additional key words:** *Fagus sylvatica*, long-term storage, quality assessment, viability loss

**Address:** Forest Gene Bank Kostrzyca, 58-535 Miłków 300, e-mail: lbg@lbg.jgora.pl

## Introduction

Forest Gene Bank Kostrzyca realizes a program of forest gene resources protection by collection and storage of seeds of most valuable tree species including beech. This species is characterised by irregular seed production.

In the FGB cold stores both long-term and strategic gene resources are stored to be used during periods of poor seed production.

Applied in the seed production methods of storage, protection, evaluation and evidence of gene resources and deposits are in use in the FGB. These methods are improved to enable restoration of abandoned and strongly changed areas before the loss of viability of the stored seeds.

Beech seeds of the following harvests were evaluated: 1995, 1998 and 2000. Quality of seeds was determined with different methods from the date of reception to the FGB through preparation for long-term storage, storage in cold stores and the presowing treatment. There were major differences in seed quality and ageing intensity.

Research objectives were:

1. developing methods of proper seed harvest, temporary storage and cleaning,
2. tests of the influence of drying on beech seeds viability,
3. comparison of seed viability tests during storage and after the presowing treatment,
4. determination of changes in quality of seed by germination tests in order to eliminate the seed lots ageing fast during storage,
5. comparison of different methods of determination of seed viability.

## Methods

### Materials

Samples of evaluated beechnuts were harvested in 1995, 1998 and 2000.

Table 1. Number and provenance of seed lots of European beech (*Fagus sylvatica* L.) tested in FGB

| Year of harvest | Deposits – D | | Gene resources – GR | | D | GR |
|---|---|---|---|---|---|---|
| | Seed provenance – Regional Forest Directorates | Number of tested lots | Seed provenance – Regional Forest Directorates | Number of tested lots | Number of tested lots | |
| 1995 | Katowice | 14 | Krosno | 4 | 104 | 5 |
| | Parki Narodowe | 2 | Zielona Góra | 1 | | |
| | Wrocław | 88 | | | | |
| 1998 | Wrocław | 32 | Szczecinek | 4 | 32 | 4 |
| 2000 | Gdańsk | 13 | Gdańsk | 16 | 151 | 33 |
| | Katowice | 14 | Lublin | 8 | | |
| | Olsztyn | 5 | Szczecinek | 8 | | |
| | Piła | 2 | Toruń | 1 | | |
| | Poznań | 3 | | | | |
| | Szczecinek | 13 | | | | |
| | Toruń | 3 | | | | |
| | Wrocław | 98 | | | | |
| Sum of deposits and gene resources | | | | | 287 | 42 |
| Total | | | | | 329 | |

Seeds for gene resources were collected from approved seed stands, while seeds for deposits – from approved, commercial seed stands and stands of other origin (Table 1).

## Method of evaluation

The following procedure was used with respect to beech seeds according to the method developed by prof. B. Suszka (Suszka et al. 1994). After having been dried to 8–10% of moisture content, the seeds were packed in sealed plastic bags (deposits) or in aluminium/plastic bags (gene resources). From each seed lot, samples were collected for laboratory analyses. All seed bags were placed in cardboard boxes and were stored at –10°C. Particular beech seed lots were after removal from storage pre-treated before sowing by cold, mediumless stratification at 3°C for sowing at dates determined by the Forest Districts.

The following analyses were performed during the particular steps of seed treatment:
- seed purity,
- moisture content,
- viability tests (cutting test preceded by cold, mediumless stratification at 3°C – CT, tetrazolium test – TT or indigo-carmine test – IC of non-dried and dried seeds),
- germination tests after the presowing treatment by cold stratification in a moist medium at 3°C, for as many as 16–20 weeks – GT,
- seedling emergence tests conducted at cyclically alternating temperature 3~20°C (16/8 hours/day) preceded by cold stratification.

Seed sampling and all evaluation tests were performed according to Anonymous (2000), Załęski et al. (1996) and Suszka et al. (1994).

# Results and discussion

## Purity test

An important factor of seed characteristics is purity. It can inform about correctness of seed collection, temporary storage, cleaning and segregation.

Beech seeds were cleaned in Forest Districts before the reception at FGB. In 2000, seeds had to undergo cleaning by floating in water. Data on the purity level of seeds from different harvest years indicate its increase. Percentage of high purity seed lots increases from 20.18% in 1995 through 47.22% in 1998 up to 83.7% in 2000. Purity of 2000 harvest lots does not fall below the allowed level.

## Preliminary drying

One of the necessary steps of beech seed treatment is preliminary drying. Moisture content with the storage temperature are crucial factors for preserving seed viability. Drying of orthodox seeds to a certain level results in a decrease of metabolic activity in living tissues. The reduced respiration level protects seeds against an accelerated use of reserve substances and enables their future mobilization (Tyszkiewicz 1949).

Drying of beechnuts was processed at 20°C, in an air stream of low relative humidity of 30%. Such drying reduces the decrease of seed quality usually observed during drying, to a minimum level (Suszka 1996).

Changes of seed viability caused by the preliminary drying at FGB were tested using the indigo-carmine test (1995 harvest, Fig. 2) and tetrazolium staining tests (1998 harvest, Fig. 3 and 2000 harvest, Fig. 4). It was found that some seed lots were sensitive to desic-

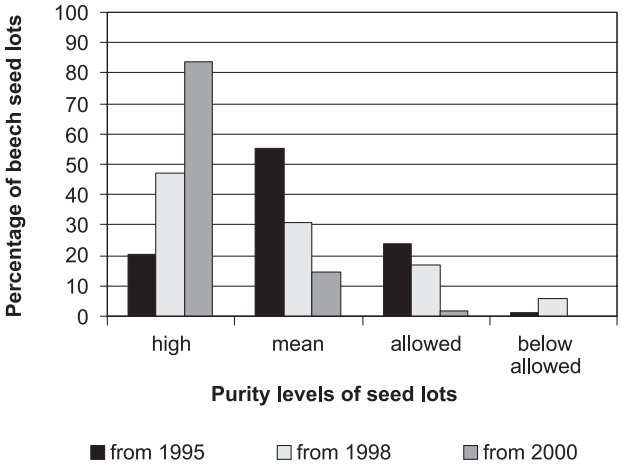


Fig. 1. Differentiation of purity levels of European beech (*Fagus sylvatica* L.) seed lots from various collection years

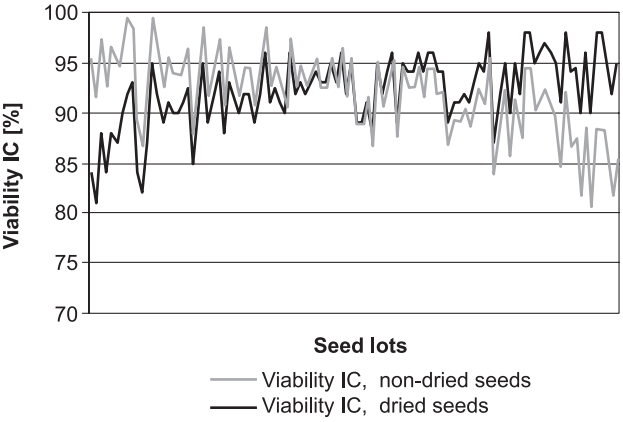


Fig. 2. Effect of drying before storage in the FGB 104 of seed lots of European beech (*Fagus sylvatica* L.) harvested in 1995 on their viability estimated by the indigo-carmine test

cation responding with a decrease of viability (by few % on average). The presence of seed lots with viability increasing during storage demonstrates considerable heterogeneity of such lots.

## Viability of beech seeds harvested in 1995

Beech seeds are characterized by deep dormancy. Indigo-carmine or tetrazolium tests are used to obtain a rapid estimation of their viability. The lower the seed quality the weaker the correlation of staining tests with the results of long-term germination test (Suszka et al. 1994).

Beech deposits (1995 harvest) were (after drying) tested in 1996 by indigo-carmine and simultaneously started germination tests. Indigo-carmine test was repeated after one year of storage, in 1997 (Fig. 5), and the results of the germination test were verified in 1998 (Fig. 6). Both methods indicated a decrease in seed viability of most lots. The indigo-carmine test demonstrated a decrease of viability by more than 30% in 68% of seed lots.

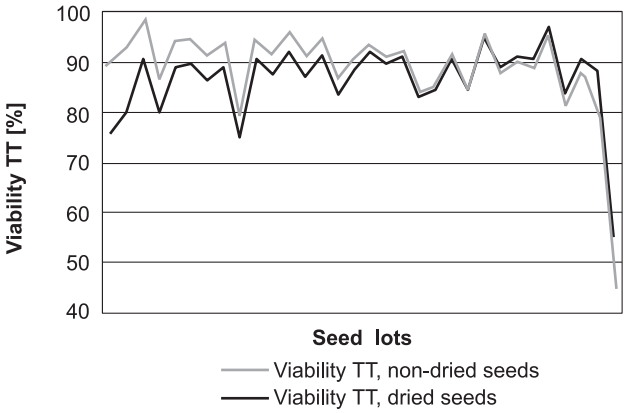


Fig. 3. Effect of drying before storage in the FGB 32 seed lots of European beech (*Fagus sylvatica* L.) harvested in 1998 on their viability estimated by the tetrazolium test

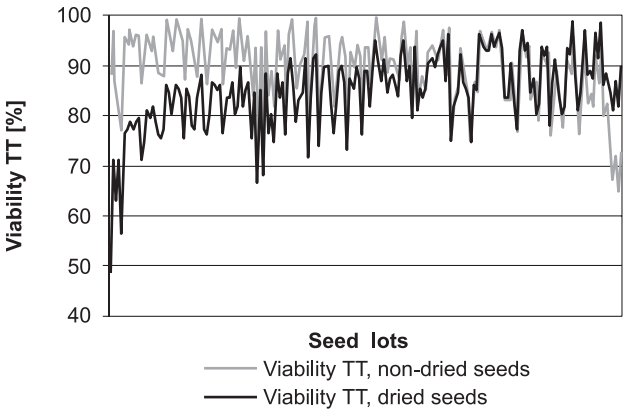


Fig. 4. Effect of drying before storage in the FGB of 182 seed lots of European beech (*Fagus sylvatica* L.) harvested in 2000 on their viability estimated by the tetrazolium test

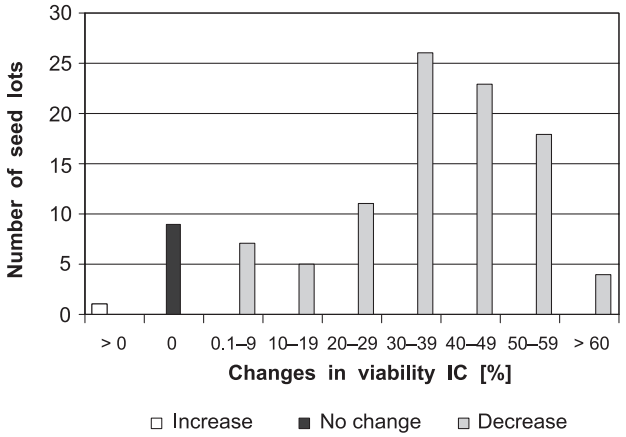


Fig. 5. Changes in viability of 104 European beech (*Fagus sylvatica* L.) deposits from 1995 expressed by the indigo-carmine tests from 1996 and 1997

In the germination test, 36% of seed lots demonstrated a decrease of viability by 11–30% (Fig. 6).

The indigo-carmine method overestimated the initial viability of beech deposits. On the other hand, the results of the first germination tests conducted in the

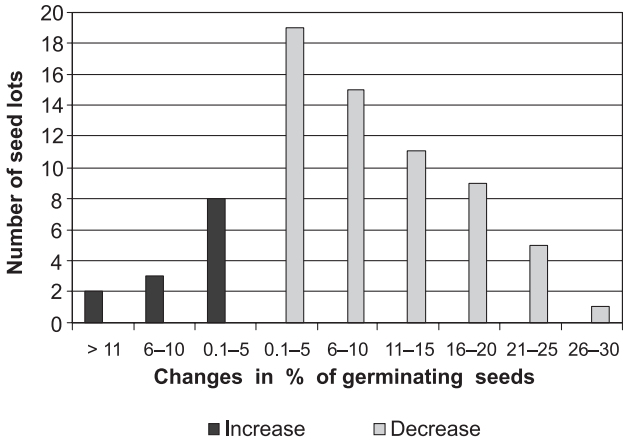


Fig. 6. Changes in viability of 73 European beech (*Fagus sylvatica* L.) deposits from 1995 expressed by comparing results of germination test from 1996 and 1998

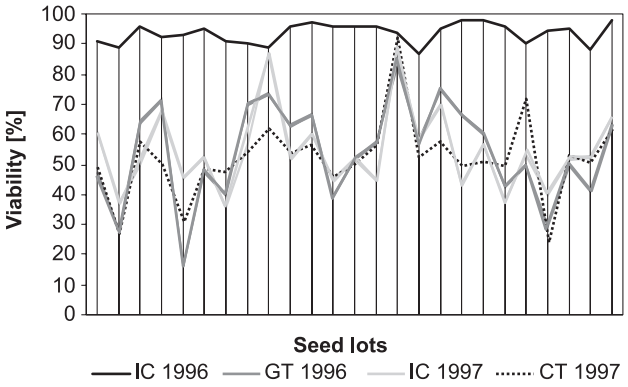


Fig. 7. Seed viability of 25 European beech (*Fagus sylvatica* L.) deposits harvested in 1995 before and after stratification in 1997

year 1996 were similar to the results of tests performed during further storage and after mediumless stratification at 3°C in spring 1997 (Fig. 7).

The results of germination test started in 1998 after 3 years of storage and of cutting tests of seeds stratified in spring 1999 indicated, for most lots, a further decrease of seed viability (Fig. 8).

There were some seed lots of very low quality among beechnut deposits from 1995 (Fig. 9). This phenomenon has not been not detected by the indigo-carmine test but in the first germination test conducted in 1996.

In contrast to seed lot 72, seed lot 34 was one of best deposits from 1995 (Fig. 10). This seed lot 34, during 4 years of storage and after seed pre-treatment in spring 1997, 2000, revealed always high seed viability independently of the applied testing method.

Besides from 1995 deposits, five other gene resources were selected for long-term storage. After five years of storage, the quality of these lots remains high and does not change so dramatically as that of other deposits (Fig. 11).

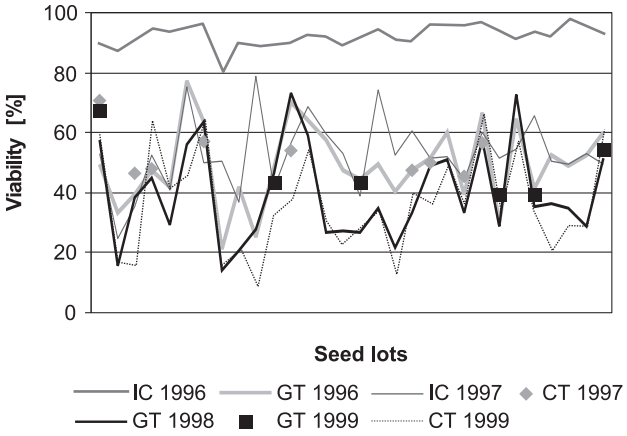


Fig. 8. Seed viability of 30 European beech (*Fagus sylvatica* L.) deposits harvested in 1995 before and after stratification in 1999

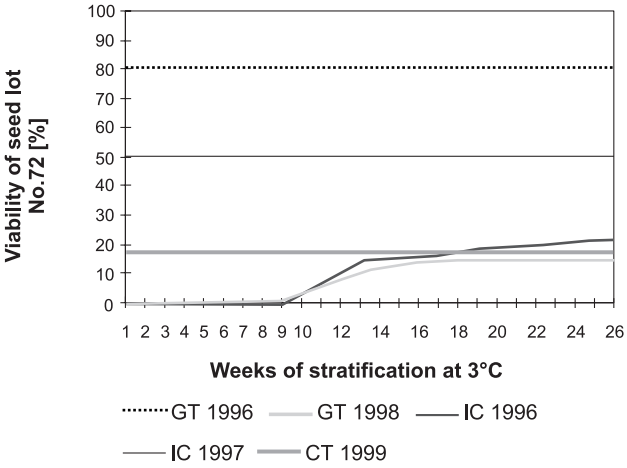


Fig. 9. Changes in viability of European beech (*Fagus sylvatica* L.) seed lot No. 72 harvested in 1995 in the Forest District Lądek Zdrój, from microregion 703

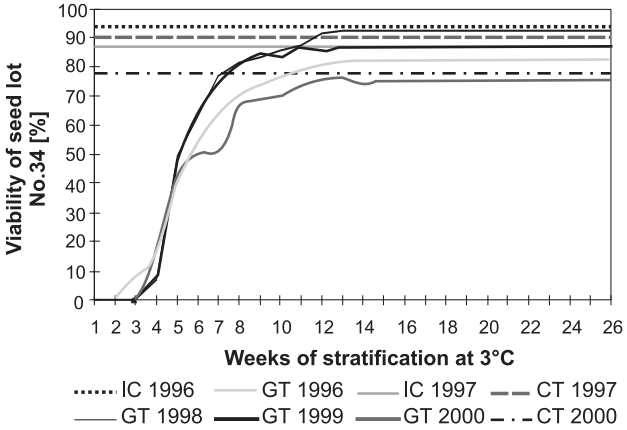


Fig. 10. Changes in viability of European beech (*Fagus sylvatica* L.) seed lot No. 34 harvested in 1995 in the Forest District Oleśnica, from microregion 553

The seeds for beech gene resources were collected separately from approved seed stands under control and this resulted in their good quality and a low decrease of viability during storage.

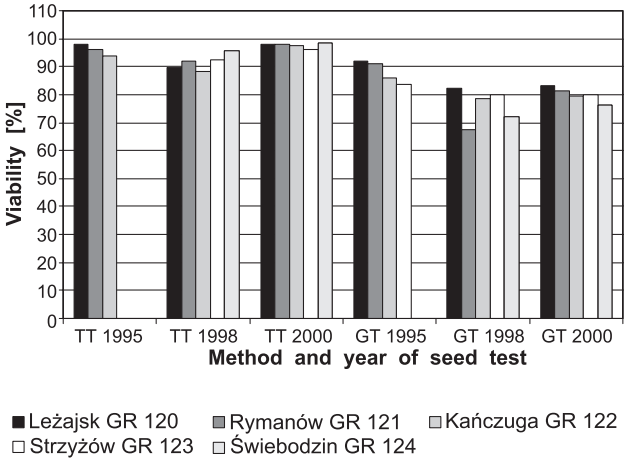


Fig. 11. Results of the tetrazolium and germination tests of European beech (*Fagus sylvatica* L.) seed gene resources harvested in 1995 and stored in the FGB

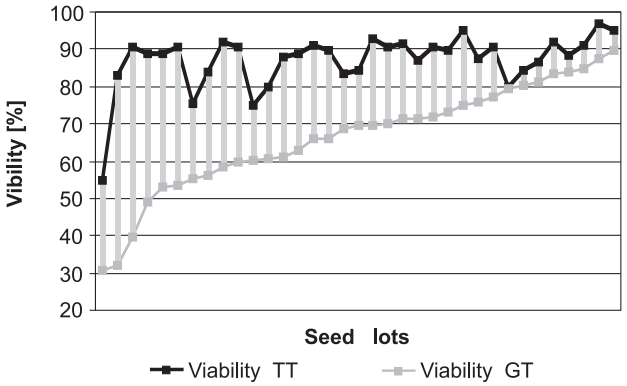


Fig. 12. Viability of 35 dried seed lots of European beech (*Fagus sylvatica* L.) harvested in 1998 and stored for one year in FGB, determined by the tetrazolium and germination tests

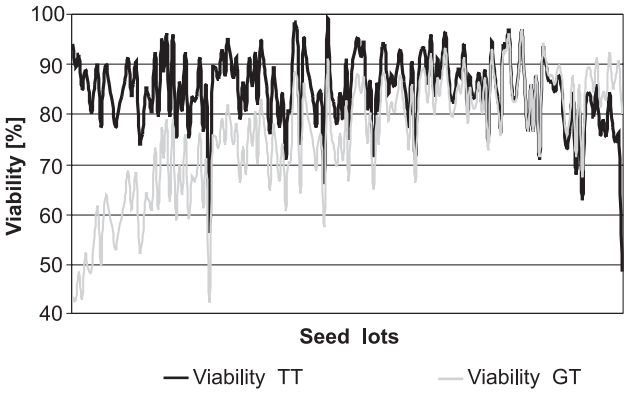


Fig. 13. Viability of 182 dried seed lots of European beech (*Fagus sylvatica* L.) harvested in 2000, estimated at the beginning of storage by the tetrazolium and germination tests

## Viability of beech seeds harvested in 1998 and 2000

Most lots of beechnuts harvested in 1998 (Fig. 12) and in 2000 (Fig. 13) demonstrated considerable differences between the results of the initial tetrazolium test of dried seeds and the germination test after stratification simultaneously started.

Among deposits with a rapid decrease of viability we find all lots harvested in 2000 collected in forest districts who share their beech seed base with other districts (Table 2). Those seeds behave very poorly during cold mediumless stratification at 3°C and in the cutting test, this being confirmed by seedling emergence tests conducted at cyclically alternating temperature 3~20°C (16/8 hours/day) preceded by cold mediumless stratification at 3°C.

# Conclusions

Basing on the obtained results we can conclude:

1. Beechnuts should be collected only from single stands, under control, avoiding mixing of different lots, this being valid not only for gene resources but also for beech deposits.
2. The floating test in water significantly improves the level of seed purity.
3. The current method of seed drying, at 20°C, in an air stream of low humidity does not remain without influence upon beech seeds and causes a slight decrease of viability.
4. The usefulness of staining tests for rapid evaluation of beech seed viability is not sufficiently sure

Table 2. Tests of European beech (*Fagus sylvatica* L.) seed lots harvested in 2000, pre-treated by stratication in spring 2001

| Seed provenance – Forest District (other owner ) | Seed lot No. | Viability non-dried seeds – TT [%] | Viability dried seeds – TT [%] | Germination test – [% ] | Seed tests after mediumless stratification at 3°C | |
|---|---|---|---|---|---|---|
| | | | | | Cutting test – [%] | Seedling emergence test – [%] |
| Międzylesie | 10 | 93.5 | 94.0 | 88.25 | 89.5 | 81.0 |
| Milicz | 224 | 87.0 | 63.0 | 67.50 | 54.0 | 45.5 |
| Zdroje | 95 | 93.0 | 83.5 | 82.00 | 46.5 | 35 |
| Świeradów (Legnica) | 86 | 83.0 | 83.5 | 81.50 | 56.0 | 40.5 |
| Henryków (Legnica) | 85 | 88.0 | 48.5 | 80.00 | 39.5 | 28.5 |
| Świeradów (Legnica) | 89 | 85.0 | 85.0 | 58.25 | 13.5 | 2.5 |

and they should be replaced with methods better correlated with the results of germination test.
5. Seed lots of low initial viability should be eliminated since low seed quality drops during storage.
6. Presence of seed lots whose viability does not decrease next to seed lots of rapidly declining quality during storage testifies to the existence of other crucial causes of accelerated seed ageing than the correctness of the applied technological processes.

## References

[Anonymous]. 2000. Materiał siewny. Nasiona drzew i krzewów leśnych i zadrzewieniowych [Seed supply. Seeds of forest trees and shrubs]. Pr PN-R-65700 Norma Branżowa. Wydawnictwa Normalizacyjne. Warszawa, 1–48.

Krzemiński W. 2001. Długookresowe przechowywanie nasion buka zwyczajnego [Long-term storage of beech seeds]. Las Polski 5: 22–23.

Matras J. 2000. Selekcyjna i gospodarcza baza nasienna buka zwyczajnego (*Fagus sylvatica* L.) w Polsce [Seed base of beech (*Fagus sylvatica* L.) in Poland for selection and commercial purpose]. Zeszyty Naukowe Akademii Rolniczej im. H. Kołłątaja w Krakowie 358: 103–120.

Mączyńska M. 1999. Przechowywanie nasion buka zwyczajnego w Przechowalni Nasion w Równem Nadleśnictwa Dukla, RDLP Krosno [Storage of beech seeds in the Równem Store of the Dukla Forest District in the Krosno Regional Forest Directorate]. Pestování sadebního materiálu z dlouhodobì skladevaného osiva buku a jedle. Česká lesninická společnost odborná skupina pro lesnické školkařstwii a semenářstvi. Hradec Králové, Sbornik referátu, 32–53.

Prochažkova Z., Bezdečková L. 1999. Srovnáni životnosti a kličivosti skladovaných bukvic. Pestování sadebního materiálu z dlouhodobì skladevaného osiva buku a jedle. Česká lesninická společnost odborná skupina pro lesnické školkařstwii a semenářstvi. Hradec Králové, Sbornik referátu, 14–17.

Rakowski K. 1997. Biochemiczne procesy wyprowadzania nasion ze stanu uśpienia po różnym okresie przechowywania – zmiany hormonalne u nasion przechowywanych w Leśnym Banku Genów w Kostrzycy [Biochemical processes for the breaking of seeds dormancy after different seed storage period – hormonal changes of the stored seeds in the Forest Gene Bank]. IBL. Sprawozdanie w temacie BLP-815.

Stocka T. 1997. Czynniki wpływające na zdrowotność nasion dębu i buka [Factories influencing for seed soundness of oak and beech]. Las Polski 11: 10, 23.

Suszka B., Bonnet-Masimbbert M., Muller C. 1994. Nasiona leśnych drzew liściastych – od zbioru do siewu [Seeds of forest deciduos trees – from harvest to sowing]. PWN, Warszawa–Poznań.

Suszka B. 1999. Zasady poprawnego postępowania z orzeszkami buka [Principle of correct beechnuts treating]. Komunikaty Leśnego Banku Genów 13: 5–9.

Suszka B. 2000. Nowe technologie i techniki w nasiennictwie leśnym [New technologies and techniques in the forest seed science]. Bogucki Wydawnictwo Naukowe, Poznań.

Suszka B. 2000. Aktualne sposoby przechowywania nasion buka [Recent methods of beechnut storage]. Zeszyty Naukowe Akademii Rolniczej im. H. Kołłątaja w Krakowie 358: 177–183.

Toka K. 2000. Ochrona zasobów genowych buka w Leśnym Banku Genów w Kostrzycy [The protection of beech genetic resources in experiments of the Forest Gene Bank Kostrzyca]. Zeszyty Naukowe Akademii Rolniczej im. H. Kołłątaja w Krakowie 358: 213–227.

Tomaszewski M., Janson L., Załęski A. 1997. Genetyczne zmiany wynikające z długoterminowego przechowywania nasion drzew [Genetic changes following from long-term storage of forest seeds]. Notatnik Naukowy IBL 6 (46): 1–6.

Tylkowski T. 1999. Przechowywanie i przysposabianie do siewu nasion drzew i krzewów pod kątem potrzeb szkółek kontenerowych i otwartych oraz Banku Genów [Storage and presowing treatment of trees and shrub for needs containerized, in open area nurseries and Gene Bank]. Instytut Dendrologii PAN w Kórniku. Sprawozdanie dla GDLP, 10–32.

Załęski A. and al. 1996. Zasady oceny nasion w Lasach Państwowych wraz z załącznikami [Rules of seed testing in Polish State Forests with annexes]. Dyrekcja Generalna Lasów Państwowych, Instytut Badawczy Leśnictwa. Warszawa.