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ANALYSIS OF VARIATIONS IN AND CORRELATIONS BETWEEN SELECTED PHYSICAL PARAMETERS OF COMMON BEECH (*FAGUS SILVATICA L.*) NUTS

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Abstract

The basic dimensions and the mass of common beech nuts and seeds from five nut batches, harvested from tree stands in northern Poland, were determined. Environmental conditions had a greater influence on seed plumpness than the age of tree stands. The results of measurements were analyzed statistically by analysis of variance, correlation analysis and linear regression analysis. Despite differences in their plumpness, nuts were characterized by nearly identical cross-sections which resembled an equilateral triangle. The thickness of nuts and seeds was highly correlated with their mass, and this information can facilitate seed husking and separation into mass categories. Before and after husking, seeds should be separated with the use of a mesh screen with longitudinal openings. Medium-sized (most numerous) seeds were separated into the following plumpness categories using a screen separator with ≠6 mm and ≠7 mm openings: 84% of moderately plump seeds, 3% of seeds with reduced plumpness, and 13% of plump seeds.

Symbols

m – seed mass [mg],
M – nut mass [mg],
SD – standard deviation of trait,

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t, w, l – seed thickness, width and length [mm],
T, W, L – nut thickness, width and length [mm],
w_1, w_2, w_3 – seed width, measured on three sides [mm],
W_1, W_2, W_3 – nut width, measured on three sides [mm],
V_s – coefficient of trait variation [%],
x – average value of trait,
x_{max}, x_{min} – maximum and minimum value of trait,
γ_1, γ_2, γ_3 – vertical angles of seed cross-section [°],
Γ_1, Γ_2, Γ_3 – vertical angles of nut cross-section [°].

Introduction

The common beech (*Fagus sylvatica* L.) is a deciduous tree species found in regions with a temperate marine climate. Its geographic range covers nearly all of Central and Western Europe (DITTMAR et al. 2003, VON OHEIMB et al. 2005, BOLTE et al. 2007, BRUS et al. 2012, JAWORSKI 2011, MAGRI 2008, PUKACKA, RATAJCZAK 2005). The common beech is a relatively slow-growing species, and it begins to produce seeds (nuts) at the age of 40–50 years in open stands and even later in dense stands. This monoecious species produces unisex and anemophilous flowers. Beech nuts mature in September to October to release 2, 3 or, less frequently, 4 triangular seeds. The external pericarp is brown, glossy, rather thin, flexible and resistant to crushing (Fig. 1). It contains one (most frequently) or two seeds (SUSZKA et al. 2000, JAWORSKI 2011).

Beech seeds are a delicacy for many forest animals, including wild boars, deer, squirrels, mice, jays and nutcrackers (SKRZYDŁOWSKI, PIOTROWSKI 2003, RUSCOE et al. 2005, JAWORSKI 2011). Seeds contain 30–36% fat, 25% protein, saponins, malic acid, citric acid and vanillic acid, 6% minerals, sugars and starch (REYES et al. 2006, PUKACKA, RATAJCZAK 2014). Raw seeds should not be consumed in large quantities because they contain small amounts of trimethylamine (fagine), a poisonous and hallucinogenic substance. Trimethylamine is removed by roasting, and purified seeds can be added to pastry and desserts or used as a coffee substitute. Beech seed oil has a very long shelf life, and its properties improve with storage time (Institute of Dendrology in Kórnik, www.idpan.poznan.pl).

Every 5 or 10 years, the yield of beech nuts per 1 ha reaches 4 tons, and seeds are produced by trees as old as 200 years (SUSZKA et al. 2000, ÖVERGAARD et al. 2007). Due to their abundance, beech nuts can be used widely in food production. According to BODYŁ and SUŁKOWSKA (2007), the demand for common beech seeds in Poland is met when approximately 10% of trees listed in the National Register of Forest Reproductive Material produce seeds. When other beech stands and seed consumption by animals are taken into account, the supply of beech seeds exceeds current demand, which indicates that the surplus could be used in food processing.

Fig. 1. View of common beech nuts: *a* – nut (seed with pericarp), *b* – husked seed with seed coat, *c* – husked seed without seed coat

The objective of this study was to determine mutual correlations between the geometric parameters and the weight of common beech nuts and seeds so as to maximize the efficiency of nut separation and husking processes.

Materials and Methods

The experimental material comprised five batches of common beech nuts supplied by a seed extraction plant in Jedwabno. Three batches were harvested from variously aged tree stands in one forest region, and two batches were obtained from similarly aged tree stands in other forest regions of northern Poland (Fig. 2). The analyzed batches were harvested from the following tree stands:

a) registration No. MP/1/1995/05, category of seed propagation material – from an identified source, region of origin – 103, municipality – Tolkmicko, geographic location – 54.18°N, 19.31°E, forest habitat – fresh forest, age – 105 years (symbol: CB-1);

b) registration No. MP/1/48559/08, category of seed propagation material – from an identified source, region of origin – 251, municipality – Kolno, geographic location – 53.54°N, 20.53°E, forest habitat – fresh forest, age – 129 years (symbol: CB-2a);

c) registration No. MP/1/12857/05, category of seed propagation material – from an identified source, region of origin – 103, municipality – Młynary, geographic location – 54.14°N, 19.40°E, forest habitat – fresh forest, age – 130 years (symbol: CB-2b);

d) registration No. MP/1/43920/05, category of seed propagation material – from an identified source (removed from the list), region of origin – 451, municipality – Lidzbark, geographic location – 53.16°N, 19.42°E, forest habitat – fresh forest, age – 124 years (symbol: CB-2c);

e) registration No. MP/1/10482/05, category of seed propagation material – from an identified source, region of origin – 103, municipality – Godkowo, geographic location – 54.06°N, 19.54°E, forest habitat – fresh forest, age – 155 years (symbol: CB-3).

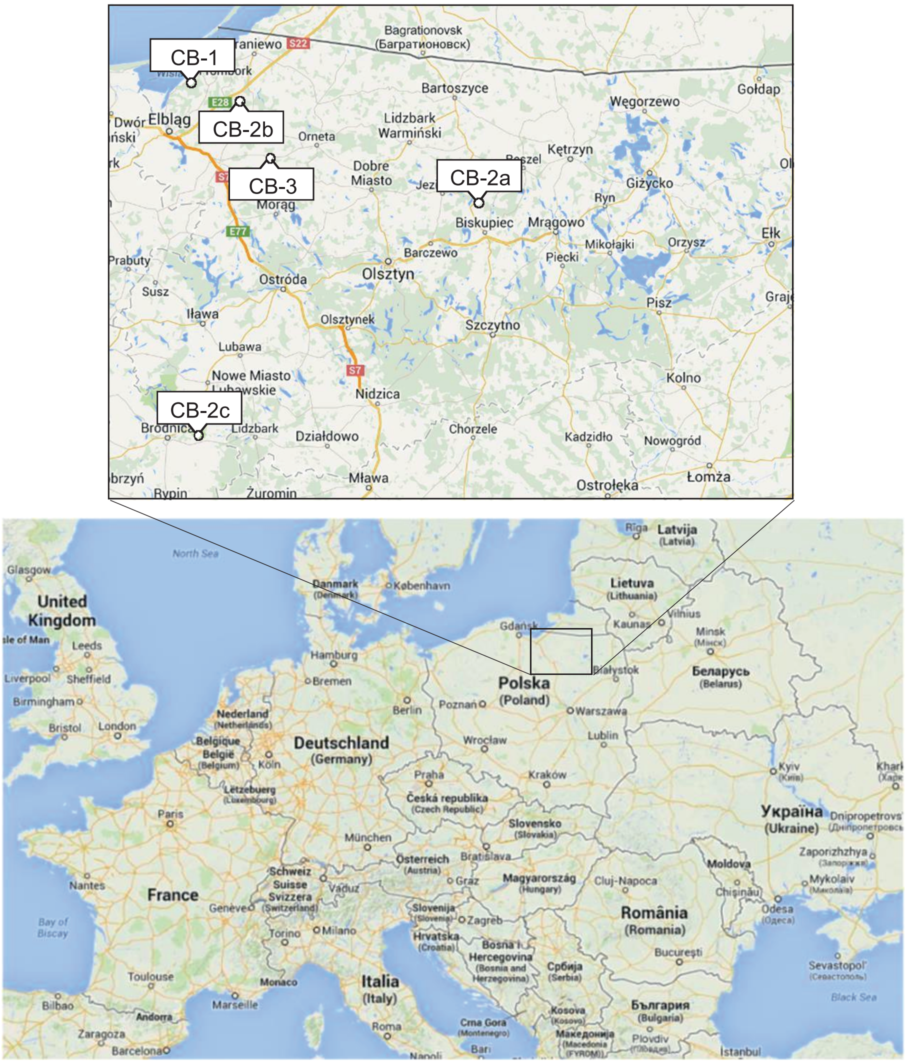

Fig. 2. Geographic location of beech tree stands

Analytical samples (initial samples had the weight of 5 kg) from every batch of nuts were divided by halving (*Nasiennictwo*... 1995). Initial samples were halved, and one half was randomly selected for successive halving. The above procedure was repeated to produce samples of around 100 nuts each.

The length and width of beech nuts were determined with the use of the MWM 2325 laboratory microscope (PZO Warszawa, Poland) to the nearest 0.02 mm (one measurement covered two micrometer readings), and nut thickness was determined with a dial thickness gauge to the nearest 0.01 mm. Beech nuts are triangular, and their width and thickness were measured on each side. Nut weight was determined on the WAA 100/C/2 laboratory scale (RADWAG Radom, Polska) to the nearest 0.1 mg. All measurements were performed according to the methods previously described by KALINIEWICZ et al. (2011) and KALINIEWICZ and POZNAŃSKI (2013).

Beech nuts were husked manually to extract seeds. The seeds were subjected to the above measurements, and correlations were determined between nut and seed parameters. The symbols describing the analyzed parameters were given in uppercase letters for nuts and in lowercase letters for seeds. Nutlets containing two seeds were excluded from further analysis due to significant variations in their shape and dimensions relative to typical seeds. Such nutlets accounted for less than 2% of the evaluated samples, which is consistent with the results reported by KALINIEWICZ et al. (2015). The analyzed nut samples had the following size: CB-1 – 105, CB-2a – 115, CB-2b – 108, CB-2c – 103, CB-3 – 109. In the examined samples, standard error for the evaluated physical parameters did not exceed:

– length of nuts and seeds – 0.3 mm,
– width and thickness of nuts and seeds – 0.2 mm,
– mass of nuts and seeds – 13 mg.

Vertical angles of nut and seed cross-sections (at the widest point) were determined with the use of the cosine formula (Carnot's theorem) which was transformed as follows:

$$\Gamma = \arc\cos \frac{W_2^2 + W_3^2 - W_1^2}{2 \cdot W_2 \cdot W_3} \qquad (1)$$

Husked seeds were divided into three plumpness categories: seeds with reduced plumpness (m < 150 mg), moderately plump seeds (m = 150÷250 mg) and plump seeds (m > 250 mg).

The results of measurements and calculations were processed in Statistica v. 10 based on standard statistical procedures, including one-way ANOVA, correlation analysis and linear regression analysis (RABIEJ 2012). The results were regarded as statistically significant at $p = 0.05$.

Results

The physical parameters of common beech nuts are presented in Table 1. The least developed nuts (lowest average length, width, thickness and mass) were noted in batch CB-2c. Batch CB-2a contained the plumpest nuts. Nuts harvested in the same region (batches CB-1, CB-2b and CB-3) differed mostly in length (differences in nut thickness and width between batches were not statistically significant). A comparison of the physical parameters of nuts harvested from similarly aged tree stands (batches CB-2a, CB-2b and CB-2c) revealed more significant differences. The above implies that the evaluated traits of beech nuts can also be influenced by the local climate.

Differences nut width, measured on each of the three sides and arranged in descending order, are presented in Table 2. Statistically significant differences in average width and, consequently, in vertical angles of nut cross-sections

Table 1

Physical parameters of common beech nuts from five batches

Parameter	Batch				
	CB-1 $x \pm SD$	CB-2a $x \pm SD$	CB-2b $x \pm SD$	CB-2c $x \pm SD$	CB-3 $x \pm SD$
L [mm]	16.86 ± 1.43^{C}	18.16 ± 1.47^{a}	17.08 ± 1.42^{Bb}	16.13 ± 1.37^{c}	17.46 ± 1.35^{A}
W [mm]	9.21 ± 0.99^{A}	9.58 ± 1.19^{a}	9.18 ± 1.00^{Ab}	8.75 ± 1.07^{c}	9.12 ± 1.03^{A}
T [mm]	8.03 ± 0.84^{A}	8.31 ± 0.98^{a}	8.00 ± 0.83^{Ab}	7.61 ± 0.88^{c}	7.93 ± 0.85^{A}
M [mg]	294.20 ± 62.56^{B}	314.71 ± 61.64^{a}	311.52 ± 60.36^{Aa}	275.93 ± 61.38^{b}	301.49 ± 67.97^{B}

$^{A, B, C}$ – different letters indicate statistically significant differences in a given parameter between nuts harvested from the same region.
$^{a, b, c}$ – different letters indicate statistically significant differences in a given parameter between nuts harvested from similarly aged tree stands.

Table 2

Width of beech nuts, measured on all sides, and vertical angles of nut cross-sections in five batches of common beech nuts

Parameter	Batch				
	CB-1 $x \pm SD$	CB-2a $x \pm SD$	CB-2b $x \pm SD$	CB-2c $x \pm SD$	CB-3 $x \pm SD$
W_1 [mm]	9.90 ± 0.86^{Ba}	10.42 ± 1.16^{Aa}	9.89 ± 0.90^{Ba}	9.44 ± 1.04^{Ca}	9.85 ± 0.97^{Ba}
W_2 [mm]	9.04 ± 0.87^{Bb}	9.34 ± 0.95^{ab}	9.06 ± 0.84^{Bb}	8.57 ± 0.90^{Cb}	8.94 ± 0.84^{Bb}
W_3 [mm]	8.70 ± 0.84^{Bc}	8.97 ± 0.94^{Ac}	8.60 ± 0.80^{Bc}	8.24 ± 0.88^{Cc}	8.56 ± 0.82^{Bc}
Γ_1 [°]	68.01 ± 4.19^{Ba}	69.51 ± 5.56^{Aa}	68.19 ± 4.38^{ABa}	68.36 ± 4.12^{ABa}	68.62 ± 4.60^{ABa}
Γ_2 [°]	57.64 ± 2.55^{ABb}	56.89 ± 3.43^{Bb}	58.08 ± 2.61^{Ab}	57.44 ± 2.42^{ABb}	57.51 ± 2.81^{ABb}
$\Gamma 3$ [°]	54.35 ± 2.27^{Ac}	53.60 ± 3.47^{Ac}	53.73 ± 2.70^{ac}	54.17 ± 2.47^{Ac}	53.87 ± 2.86^{Ac}

$^{A, B, C}$ – different letters indicate statistically significant differences in a given parameter between nuts from different batches.
$^{a, b, c}$ – different letters indicate statistically significant differences in a given parameter between nuts from the same batch.

were observed in all batches. A comparison of the widest, average and narrowest nut sides in the analyzed batches indicates that CB-2a and CB-2c differed significantly from the remaining batches, whereas no significant differences were noted in their respective vertical angles. Statistically significant differences were observed only in angle Γ_1 between batches CB-2a and CB-1 and in angle Γ_2 between batches CB-2a and CB-2b. The above results indicate that cross-sectional shape is not determined by harvesting site or the age of trees.

The correlations between the physical parameters of seeds were generally similar to those noted between the analyzed parameters of nuts (Fig. 3). Significant differences were observed only in batch CB-2c which was characterized by the smallest seed dimensions and the lowest seed mass. The average values of seed properties varied in the following range: length – from 12.1 to 13.2 mm, width – from 6.8 to 7.3 mm, thickness – from 6.1 to 6.5 mm, mass

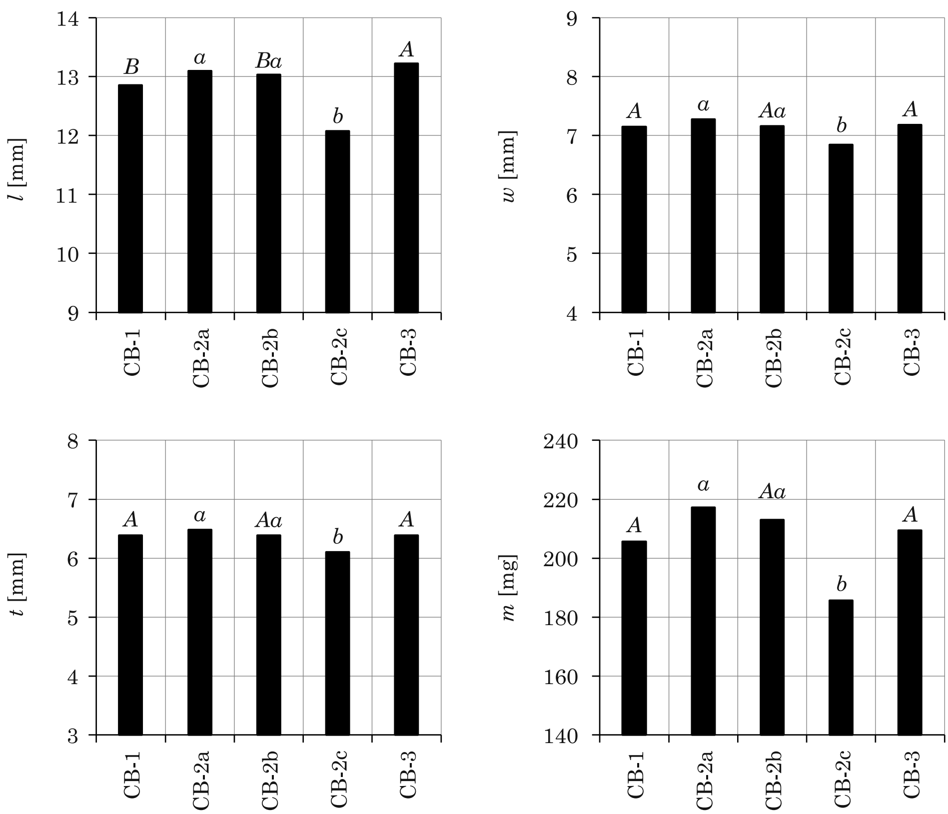

Fig. 3. Average values of seed parameters: *A*, *B* – different letters indicate statistically significant differences in a given parameter between nuts from the same region; *a*, *b* – different letters indicate statistically significant differences in a given parameter between nuts from similarly aged tree stands

– from 185.7 to 217.2 mg. Similarly to nuts, more statistically significant differences in physical parameters were noted between seeds harvested from similarly aged tree stands in different regions than between seeds obtained from variously aged tree stands in the same region.

The width of seeds (extracted from nuts), measured on each side and at the widest point, from every analyzed batch is presented in Table 3. A comparison of the width of corresponding seed sides did not reveal statistically significant differences, except for batch CB-2c. Significant differences in vertical angles were not observed in any of the evaluated batches.

Table 3

Width of beech seeds, measured on all sides, and vertical angles of seed cross-sections in five batches of common beech nuts

Parameter	Batch				
	CB-1 $x \pm SD$	CB-2a $x \pm SD$	CB-2b $x \pm SD$	CB-2c $x \pm SD$	CB-3 $x \pm SD$
w_1 [mm]	7.64 ± 0.67^{Aa}	7.81 ± 0.70^{Aa}	7.63 ± 0.65^{Aa}	7.31 ± 0.79^{Ba}	7.69 ± 0.78^{Aa}
w_2 [mm]	7.05 ± 0.68^{Ab}	7.17 ± 0.67^{ab}	7.10 ± 0.63^{Ab}	6.76 ± 0.74^{Bb}	7.07 ± 0.69^{Ab}
w_3 [mm]	6.76 ± 0.67^{Ac}	6.86 ± 0.65^{Ac}	6.76 ± 0.60^{Ac}	6.47 ± 0.70^{Bc}	6.78 ± 0.68^{Ac}
γ_1 [°]	67.25 ± 3.43^{Aa}	67.75 ± 4.55^{Aa}	66.86 ± 3.61^{Aa}	67.06 ± 3.62^{Aa}	67.45 ± 4.23^{Aa}
γ_2 [°]	58.20 ± 2.25^{Ab}	58.01 ± 3.05^{Ab}	58.70 ± 2.24^{Ab}	58.34 ± 2.54^{Ab}	58.08 ± 2.65^{Ab}
γ_3 [°]	54.55 ± 2.05^{Ac}	54.24 ± 2.95^{Ac}	54.44 ± 2.51^{Ac}	54.60 ± 2.49^{Ac}	54.47 ± 2.78^{Ac}

$^{A, B, C}$ – different letters indicate statistically significant differences in a given parameter between seeds from different batches.

$^{a, b, c}$ – different letters indicate statistically significant differences in a given parameter between seeds from the same batch.

Despite local statistical differences, seeds from the five tested batches were regarded as homogeneous. The following ratios were determined between the compared physical parameters of nuts and seeds: $L/l = 1.34 \pm 0.06$, $W/w = 1.29 \pm 0.07$, $T/t = 1.26 \pm 0.07$, $M/m = 1.47 \pm 0.09$.

A linear correlation analysis revealed that all physical parameters of common beech nuts and seeds (Tab. 4) were significantly correlated at 0.05. The highest value of the correlation coefficient (0.98) was observed between the masses of nuts and seeds, and the lowest value (0.29) – between seed thickness and nut length. Strong correlations were generally noted between the corresponding parameters of nuts and seeds (from 0.87 for length to 0.98 for mass), which influenced the value of the coefficient of determination in linear regression equations describing the above traits.

Equations where the coefficient of determination is higher than 0.2 are presented in Table 5. Seed mass was significantly correlated with all evaluated traits of beech nuts and seeds. The highest value of the coefficient of determination and the equation with the highest proportion of explained variation

Table 4

Coefficients of linear correlation between selected physical parameters of beech nuts and seeds

Parameter	W	T	M	l	w	t	m
L	0.338	0.338	0.557	0.869	0.303	0.290	0.532
W	1	0.413	0.666	0.327	0.894	0.343	0.610
T		1	0.701	0.336	0.385	0.897	0.646
M			1	0.644	0.749	0.762	0.979
l				1	0.359	0.350	0.644
w					1	0.442	0.736
t						1	0.752

All correlations are statistically significant at 0.05.

were noted for the correlation between seed mass and nut mass (0.96). Nut thickness and seed thickness were most highly correlated with seed mass. The above observation suggests that common beech seeds would be most effectively separated into fractions with the use of a mesh screen with longitudinal openings.

Table 5

Regression equations for the physical parameters of beech seeds

Equation	Coefficient of determination R_2	Standard error of estimate
$l = 0.672\ L + 1.344$	0.755	0.597
$l = 0.012\ M + 9.241$	0.415	0.922
$l = 0.016\ m + 9.663$	0.415	0.922
$w = 0.649\ W + 1.173$	0.801	0.353
$w = 0.009\ M + 4.362$	0.560	0.525
$w = 0.012\ m + 4.726$	0.541	0.537
$t = 0.700\ T + 0.761$	0.804	0.313
$t = 0.008\ M + 3.833$	0.581	0.458
$t = 0.011\ m + 4.156$	0.565	0.467
$m = 17.056\ L - 86.177$	0.283	42.419
$m = 27.972\ W - 50.152$	0.372	39.683
$m = 35.673\ T - 78.278$	0.417	38.232
$m = 0.763\ M - 22.371$	0.959	10.110
$m = 26.753\ l - 137.726$	0.415	38.301
$m = 46.504\ w - 125.002$	0.541	33.929
$m = 53.191\ t - 131.255$	0.565	33.022

In line with the adopted classification system, husked nutlets will produce 13% of poorly filled seeds (m < 150 mg), 69% of moderately plump seeds (m = 150÷250 mg) and 18% plump seeds (m > 250 mg). Nuts can be separated into six fractions based on their thickness (Figure 4). Every fraction contains nuts whose seeds can be classified into three mass categories. The only exceptions are the finest (T < 6.01 mm) and coarsest (T > 10 mm) fractions which do not contain plump seeds and poorly filled seeds, respectively.

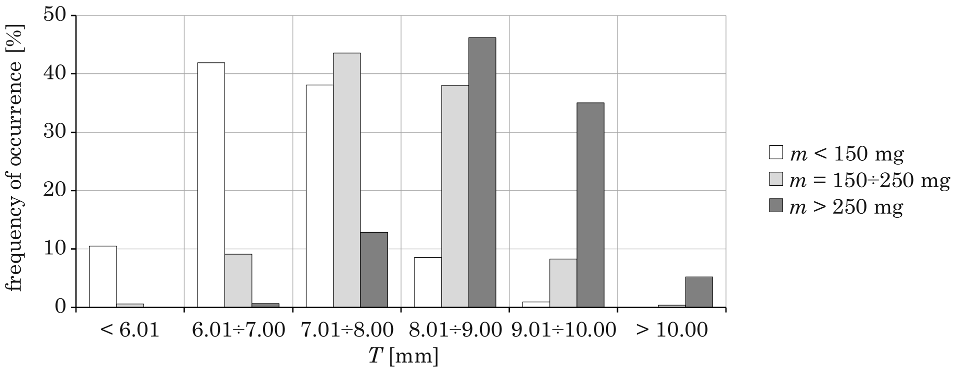

Fig. 4. Distribution of nut thickness across three mass categories of husked seeds

The data presented in Table 4 indicates that seed mass is most highly correlated with seed thickness, which implies that seeds can be effectively sorted with the use of a mesh screen with longitudinal openings. Seeds can be sorted into five size fractions (Fig. 5) with evenly distributed mass. Two mesh screens with ≠6 mm and ≠7 mm openings can be used to separate seeds into three size fractions, where the finest fraction contains approximately 89% of poorly filled seeds, 27% of moderately plump seeds and only 2% of plump seeds. The coarsest fraction will comprise only moderately plump seeds (approximately 10%) and plump seeds (approximately 58%). The above indicates that the medium-sized fraction will contain approximately 11% of poorly filled seeds, 62% of moderately plump seeds and 40% of plump seeds. The analyzed size fractions were characterized by the following share of plumpness categories:

– finest fraction ($t \leq 6$ mm) – 37.4% of poorly filled seeds, 61.4% of moderately plump seeds and 1.2% of plump seeds,

– medium fraction ($t = 6 \div 7$ mm) – 2.8% of poorly filled seeds, 83.9% of moderately plump seeds and 13.3% of plump seeds,

– coarsest fraction ($t > 7$ mm) – 41.3% of moderately plump seeds and 58.7% of plump seeds.

Discussion

The evaluated beech nuts were more filled than those analyzed by BODYŁ and SUŁKOWSKA (2007), and they were nearly identical with those examined by TYLEK (2010) and KALINIEWICZ et al. (2015). The average length of the evaluated beech nuts was similar to that of pumpkin seeds (JOSHI et al. 1993), squash seeds (JACOBO-VALENZUELA et al. 2011) and kidney beans (ALTUNTAS, DEMIRTOLA 2007).

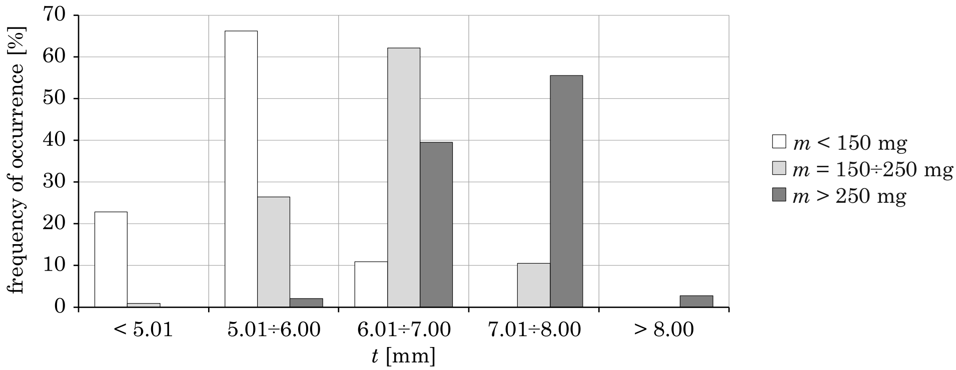

Fig. 5. Distribution of seed thickness across three weight categories

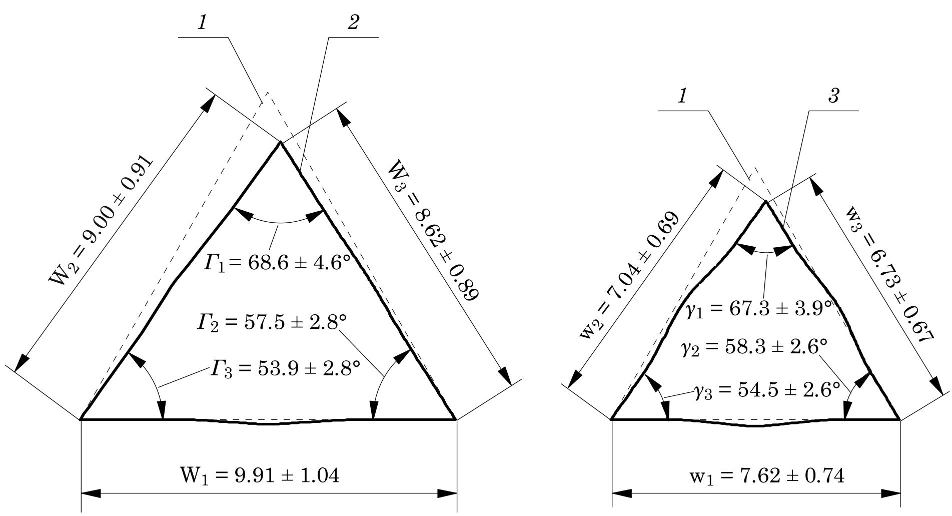

Fig. 6. Cross-sectional shape of the largest beech nuts (*2*) and seeds (*3*) shown against an equilateral triangle (*1*)

A comparison of the physical properties of beech nuts and seeds revealed greater variations between batches that were harvested from similarly aged tree stands in different regions than between batches obtained from variously aged tree stands in the same region. The above implies that nut filling is more likely to be influenced by local environmental conditions than the age of the tree. Similar observations were made by KALINIEWICZ et al. (2013) in a study of pine seeds harvested from parent trees aged 124 to 180 years. The reported differences in the dimensions of pine seeds were statistically significant, but not large enough to necessitate adjustment of mesh screen parameters. Seed dimensions generally decrease with the age of parent trees. In this study, the length of the examined nuts increased with tree age (105 to 155 years), which could be attributed to the fact that the generative phase begins relatively late in the common beech (JAWORSKI 2011), which delays the onset of old age when reproductive performance gradually declines.

Similarly to buckwheat nutlets and knotweed seeds, beech nuts are triangular, but they are much larger than the compared seeds. On average, even the lightest beech nuts are five-fold heavier than buckwheat nutlets (CAMPBELL 2003, KRAM et al. 2007) and 55-fold heavier than pale knotweed seeds (MATUSIEWICZ et al. 2014). The cross-section of common beech nuts resembles an equilateral triangle (TYLEK 2010). In this study, the differences in the width of nuts and seeds, measured on all sides and at the widest point, were statistically significant at 0.05 (Tab. 2 and 3, Fig. 5). Differences were observed in the vertical angles of nut cross-sections which were determined at 68.6, 57.5 and 53.9° in nuts and 67.3, 58.3 and 54.5° in husked seeds on average. The average width of beech nuts and seeds, measured on each of the three sides, was determined at:

– T_1 = 7.44 ± 0.81 mm, t_1 = 5.92 ± 0.66 mm,
– T_2 = 8.09 ± 0.79 mm, t_2 = 6.43 ± 0.61 mm,
– T_3 = 8.42 ± 0.83 mm, t_3 = 6.70 ± 0.63 mm.

Nut dimensions were highly correlated with nut mass, and similar observations were made by TYLEK (2010) and KALINIEWICZ et al. (2015). Similar correlations were noted between seed dimensions and seed mass. Nut parameters significantly influenced the characteristic traits of husked seeds.

On average, beech nuts are 1.47-times heavier than the extracted seeds, and the mass of a seed accounts for 68% of nut mass. In the common beech, the ratio of nut thickness to seed thickness is 5% higher than that reported in pumpkin seeds (JOSHI et al. 1993) and 15% higher than that noted in locust beans (OGUNJIMI et al. 2002). In the analyzed tree species, the ratio of nut width to nut length and the ratio of seed width to seed length was higher by 2% and 18% in comparison with pumpkin seeds, respectively, and by 16% and 22% in comparison with locust beans, respectively. The above results indicate that beech nuts contain more empty space than the seeds of the compared plants. In the analyzed seeds, the nut mass to seed mass ratio was approximately 17% higher than in pumpkin seeds and approximately 11% lower than in locust beans. In beech seeds, the pericarp's share of nut mass was higher than the share of the seed coat in the mass of locust beans and lower than the share of the seed coat in the mass of pumpkin seeds. The nut size to nut mass ratios and the seed size to seed mass ratios in the common beech were very similar to those reported in buckwheat nutlets (KRAM et al. 2007). The above findings indicate that beech nuts should be husked in a similar manner to buckwheat nutlets. Seeds should be divided into several size fractions, and each fraction should be directed to a different husking device set to the corresponding parameters (JURGA 1997).

The presented correlations between the physical properties of beech nuts and seeds can be used to maximize the effectiveness of separation and husking processes, in particular during the development of separation and husking models. For a biological material, the noted results are characterized by relatively high fit to empirical data, and they can be used to improve seed treatment processes.

Conclusions

1. Despite differences in plumpness, which were conditioned by external factors and genetic traits, common beech nuts and seeds were characterized by similar cross-sectional shape. The examined cross-sections had the shape of a triangle whose sides differed significantly in length, and vertical angles were determined at 68.6, 57.5 and 53.9° in nuts and 67.3, 58.3 and 54.5° in seeds on average.
2. In both nuts and seeds, the three basic dimensions (thickness, width and length) were significantly correlated with mass, and significant correlations were also noted between the evaluated parameters. The highest value of the correlation coefficient was observed between nut mass and seed mass (approximately 0.98). The correlation coefficient was relatively high (above 0.85) in comparisons of nut and seed dimensions. Regression equations had relatively high coefficients of determination. The noted results were characterized by satisfactory fit to empirical data, and they can be used to improve the efficiency of nut cleaning and husking processes.
3. Before husking, beech nuts should be separated into size categories with the use of mesh screens with longitudinal openings. Husked seeds should be further sorted (jointly or separately for each fraction) into different mass categories, which can be achieved with the use of mesh screens with ≠6 mm and ≠7 mm openings.

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