THE STUDY OF THE PHYSICO-CHEMICAL CHARACTERISTICS OF PUMPKIN SEEDS (*CUCURBITA MAXIMA* DUCH.) CULTIVATED IN THE SOUTH OF OLTENIA

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Abstract

The aim of this study was to provide information on the physico-chemical characteristics of the seeds of pumpkin varieties and genotypes, grown on the sandy soils of southern Oltenia. Different physico-chemical characteristics of whole pumpkin seeds were analyzed. So, the length, width and thickness recorded, in the two years of the study, average values between 17.26 -20.58 mm; 11.06 - 11.74 mm; and 4.11 - 4.55 mm in 2021, respectively 17.64 - 22.10 mm; 10.67 -12.80 mm and 3.77 - 4.93 mm, in the year 2022. Seed weight, another characteristic determined, varied in the two years of the study between 0.26 – 0.32g (2021) and 0.25 – 0.46g (2022). Based on the measurements, sphericity and shape indices were calculated. Regarding the chemical composition of pumpkin seeds, in 2022 the content of moisture, protein and oil was determined.

Key words*: pumpkin, seeds, variability, physico-chemical properties*

INTRODUCTION

Pumpkin belongs to the genus *Cucurbita*, of the family *Cucurbitaceae* and includes many species of which the best known are *Cucurbita pepo* L. , *Cucurbita moschata* Duchesne and *Cucurbita maxima* Duchesne. The pumpkin fruit is used in the processing of various food products and is cultivated all over the world presenting food, ornamental and commercial importance (DEVI et al.,2018). It was brought by the Spanish to Europe in the 16th century with the conquest of Middle America. Due to its edible pulp and seeds, it was cultivated for many years as a vegetable and forage plant(ORŁOWSKI, 2000; KALINIEWICZ, 2014). On the territory of Romania, the cultivation of edible pumpkin appeared in the middle of the 17th century, first in Wallachia, and later in Moldova. Currently, in our country,edible pumpkin is cultivated on relatively large areas, especially in the southern, south-western and partly south-eastern areas, both in staple crops and in combined crops with maize (APOSTOL et al.,2018).

Cucurbita maxima Duch. is one of the five species of *Cucurbita* sp. cultivated for its flesh, flowers and seeds (APOSTOL et al., 2018). Pumpkin seeds are most often consumed as a roasted and salted snack, but are also used in various confectionery and bakery products (NAWIRSKA et al., 2013).The main components of pumpkin seeds are proteins (mostly albumin and globulins) and oil (LELLEY et a., 2009). In addition, pumpkin seeds contain minerals (especially potassium, phosphorus and magnesium), phytosterols, carotenoids and tocopherols that make pumpkin seeds valuable in helping to prevent chronic diseases. However its use as a cooking oil

is limited by its strong colour and flavour (JAFARI et al., 2012). Pumpkin seeds and pumpkin seed oil have recently captured the attention of consumers due to their antidiabetic, antihypertensive, antitumor, immunomodulatory, antibacterial, intestinal antiparasitic, and anti-inflammatory properties (SALGIN et al.,2011). Determination of physical characteristics of agricultural products is of particular importance in the design of post-harvest technologies and in the correct interpretation of essential parameters and characteristics (MOHSENIN, 1986). In addition, determination of physical characteristics is important in terms of assessing the quality of the final product and placing it within quality standards (TANER et al.,2015).
The aim of this study was to determine the main physico-chemical characteristics of pumpkin seeds, so that the results obtained could provide consumers with information on their importance and health benefits, as well as serve future research programs on pumpkin cultivation on sandy soils in southern Oltenia.

MATERIALS AND METHODS

Material

The study was carried out on pumpkin seeds obtained from 3 varieties (*Marele Alb*, *Coroana Prințului*, *Tudor*) and 3 genotypes (*D19*, *P1*, *P3*) of pumpkin, grown in the experimental field of RDSPCS Dăbuleni, during the study years 2021 - 2022.

Method

Physical characteristics. After harvesting the seeds were dried at room temperature for 2 weeks. From the total number of harvested seeds, 50 seeds per variety or genotype were randomly selected. Biometric measurements of the seeds regarding length, width and thickness were performed using an electronic caliper with ultra-fast display with an accuracy of 0.01 mm and the weight of the seeds with an electronic balance with an accuracy of 0.02g, according to the methodology described by IONICĂ (2014).
To determine the shape of the seeds, sphericity indices were calculated according to the formulas: $K_m = \frac{l}{L}$(mm), $K_w = \frac{Gr}{L}$ (mm), described by GROCHOWICZ (1994), respectively the shape index according to the formula $IF = \frac{2L}{(l+Gr)}$(mm), described by SAYINCI et al. (2015).

Chemical characteristics.

In 2022, moisture (%), protein (%) and oil (%) content determinations were carried out with the Perten seed quality analyser.

Statistical analysis

The data obtained were statistically processed using the descriptive statistical program (StatPoint Technologies, Warrenton, VA, USA).

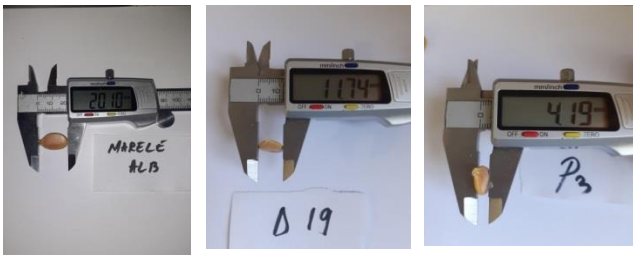

Figure 1. Mesurements of pumpkin seeds

RESULTS AND DISCUSSIONS

Table 1 and 2 present the results on the variability of physical and quantitative characteristics, of *Cucurbita maxima* Duchesne seeds grown on sandy soils in the two calendar years 2021 – 2022. According to the data in Table 1, in 2021 the highest coefficient of variability was calculated for the weight of a seed in genotype *D19* (33.8%) and the lowest for the length of a seed in genotype *P1* (2.6%). The weight of a seed recorded average values between 0.26g (*P1*) and

0.32g (*Marele alb*) with limits of variation between 0.08g and 0.60g in genotype *D19*.

Table 1. Physical characteristics of pumpkin seeds in the year 2021

Variety / Genotype	Statistical analysis	Characteristics			
		L (mm)	l (mm)	Gr(mm)	Gs (g)
Marele alb	Mean ± SD	20,58 ± 1,17	11,23 ± 0,73	4,15 ± 0,44	0,32 ± 0,07
	Variation Limits	18,19/ 23,17	9,05 / 12,09	3,15 / 4,85	0,13 / 0,45
	CV%	5,7	6,52	10,71	23,59
Coroana prințului	Mean ± SD	18,96 ± 0,85	11,36 ± 0,61	4,55 ± 0,49	0,31 ± 0,04
	Variation Limits	17,15 / 20,88	10,15 / 12,79	3,67 / 5,83	0,12 / 0,35
	CV%	4,46	5,42	10,7	12,44
Tudor	Mean ± SD	19,63 ± 1,23	11,74 ± 0,74	4,11 ± 0,50	0,28 ± 0,03
	Variation Limits	12,23 / 20,65	9,71 / 13,81	3,30 / 5,03	0,22 / 0,33
	CV%	6,28	6,31	12,15	10,03
D19	Mean ± SD	18,71 ± 2,46	11,06 ± 0,53	4,19 ± 0,51	0,27 ± 0,09
	Variation Limits	14,00 / 21,82	10,15 / 12,00	3,00 / 4,98	0,08 / 0,60
	CV%	13,16	4,81	12,25	33,8
P1	Mean ± SD	19,71 ± 0,51	11,18 ± 0,47	4,45 ± 0,35	0,26 ± 0,06
	Variation Limits	18,76 / 21,16	10,25 / 12,15	3,45 / 5,50	0,10 / 0,33
	CV%	2,6	4,24	7,77	22,86
P3	Mean ± SD	17,26 ± 1,16	11,45 ± 0,75	4,13 ± 0,38	0,28 ± 0,04
	Variation Limits	14,58 / 19,45	9,85 / 12,98	3,20 / 4,88	0,18 / 0,38
	CV%	6,75	6,56	9,29	12,6

L = seed length; l = seed width;Gr = seed thickness; Gs = seed weight; SD = standard deviation; CV %= coefficient of variability

In terms of the length of a seed, the *Marele Alb* variety stood out in 2021, with an average value of 20.58 mm and limits of variation between 18.19 mm and 23.17 mm. The width of a seed had an average value ranging from 11.06 mm (D19) to 11.74 mm (*Tudor*), and the thickness of a seed had the highest average value of 4.55 mm in the variety *Coroana Prințului* , with variation limits of 3.00 mm (*D19*) and 5.83 mm (*Coroana Prințului*) in the calendar year 2021.

In the year 2022 for the length of a seed, the variety *Tudor* stood out with an average value of 22.10 mm and variation limits between 20.89 mm and 23.44 mm, the lowest value being recorded for the variety *Coroana Prințului*. The width of a seed showed the highest average value of 12.80 mm in genotype *D19* as in 2021, and the lowest of 10.67 mm in the variety *Coroana Prințului*.

The data obtained for length and width of a seed are comparably higher than those obtained by KALINIEWICZ et al., in 2014, respectively 16.06-27.10 mm for length and between 9.57 and 16.98 for width.

Table 2. Physical characteristics of pumpkin seeds in 2022

Variety/ Genotype	Statistical analysis	Characteristics			
		L (mm)	l (mm)	Gr(mm)	Gs (g)
Marele alb	Mean ± SD	20,58 ± 0,76	12,11 ± 0,59	4,51 ± 0,36	0,37 ± 0,06
	Variation Limits	18,98 / 22,23	10,84 / 13,20	3,50 /5,04	0,11 / 0,44
	CV%	3,69	4,85	8,02	15,12
Coroana prințului	Mean ± SD	17,64 ± 1,33	10,67 ± 0,69	4,33 ± 0,43	0,25 ± 0,03
	Variation Limits	11,05 / 19,22	9,50 / 12,12	3,23 / 5,11	0,17 /0,30
	CV%	7,52	6,45	9,93	12,78
Tudor	Mean ± SD	22,10 ± 0,48	12,44 ± 0,67	3,77 ± 0,29	0,31 ± 0,04
	Variation Limits	20,89 / 23,41	10,13 / 13,57	3,25 / 4,40	0,10 / 0,36
	CV%	2,17	5,41	7,81	12,63
D19	Mean ± SD	21,21± 1,07	12,80 ± 0,67	4,93 ± 0,37	0,46 ± 0,04
	Variation Limits	18,82 / 23,19	10,50 / 13,70	4,10 / 5,58	0,35 / 0,53
	CV%	5,06	5,23	7,48	7,88
P1	Mean ± SD	20,19 ± 0,62	11,37 ± 0,46	4,51 ± 0,30	0,33 ± 0,04
	Variation Limits	18,47 / 21,67	10,31 / 12,45	3,70 / 5,22	0,20 / 0,41
	CV%	3,06	4,08	6,71	12,03
P3	Mean ± SD	22,03 ± 0,89	11,15 ± 0,57	4,77 ± 0,40	0,36 ± 0,04
	Variation Limits	19,29 /23,25	10,05 / 12,26	3,76 /5,42	0,22/ 0,45
	CV%	4,02	5,13	8,4	12,04

L = seed length; l = seed width;Gr = seed thickness; Gs = seed weight; SD = standard deviation; CV %= coefficient of variability

In terms of seed thickness, in 2022 this characteristic recorded the lowest average value of 3.77 mm in the variety *Tudor* and the highest of 4.93 mm in the genotype *D19*, with limits of variation between 3.23 mm (*Coroana Prințului*) and 5.58 mm (*D19*). The highest variation coefficient was

recorded in 2022 in terms of seed weight, i.e. 15.12% in the variety *Marele Alb*.

This characteristic showed an average value ranging from 0.25g in the *Coroana Prințului* variety to 0.46g in genotype *D19* .

In the literature KALINIEWICZ et al. in 2014 mention a seed thickness value between 1.83 and 5.04 mm, values much lower than those obtained in the two years of research.

Table 3 shows the results for sphericity and shape indexes, calculated from measurements made in the two calendar years 2021 and 2022.

Analysing the results obtained in Table 3, it can be seen that the lowest coefficient of variability was recorded for the sphericity index Km of 3.80% in 2022 in *Marele Alb* and the highest of 15.14% for the sphericity index Kw in *Tudor*.

Table 3.Values of sphericity and shape indices in pumpkin seeds during the research period 2021-2022

Variety/ Genotype	Statistical analysis	Years of studies					
		2021			2022		
		Km (mm)	Kw (mm)	If	Km (mm)	Kw (mm)	If
Marele alb	Mean ± SD	0,55 ± 0,04	0,20 ± 0,02	2,69 ± 0,22	0,59± 0,02	0,22 ± 0,02	2,48 ± 0,10
	Variation Limits	0,45 / 0,65	0,14 / 0,24	2,25 / 3,23	0,53 /0,64	0,17 /0,25	2,28 / 2,72
	CV%	8,17	11,61	8,08	3,80	7,28	3,99
Coroana prințului	Mean ± SD	0,60 ±0,04	0,24 ± 0,03	2,40 ± 0,18	0,61 ± 0,06	0,25 ± 0,03	2,36 ± 0,20
	Variation Limits	0,51 / 0,74	0,20 / 0,34	1,85 / 2,79	0,53 / 0,93	0,17 / 0,39	1,52 / 2,71
	CV%	7,26	12,55	7,61	10,47	12,44	8,53
Tudor	Mean ± SD	0,60 ± 0,07	0,21 ± 0,03	2,48 ± 0,21	0,56 ± 0,03	0,17 ± 0,01	2,73 ± 0,14
	Variation Limits	0,47 / 0,96	0,17 / 0,34	1,54 / 2,97	0,48 / 0,68	0,15 / 0,20	2,48 / 3,09
	CV%	11,06	15,14	8,49	5,45	7,75	5,25
D19	Mean ± SD	0,60 ± 0,07	0,23 ± 0,03	2,45 ± 0,27	0,61 ± 0,04	0,23 ± 0,02	2,40 ± 0,16
	Variation Limits	0,51 / 0,74	0,15 / 0,34	1,86 / 2,93	0,51 /0,72	0,19 /0,27	2,07 /2,74
	CV%	11,72	14,86	10,85	7,09	9,11	6,54
P1	Mean ± SD	0,57 ± 0,03	0,23 ± 0,02	2,53 ± 0,10	0,56 ± 0,03	0,22 ± 0,02	2,55 ± 0,11
	Variation Limits	0,51 / 0,63	0,18 / 0,29	2,25 / 2,69	0,51 / 0,61	0,18 / 26	2,33 / 2,90
	CV%	4,63	7,87	3,86	4,57	6,92	4,42
P3	Mean ± SD	0,67 ± 0,05	0,24 ± 0,02	2,26 ± 0,15	0,51 ± 0,03	0,22 ± 0,02	2,77 ± 0,17
	Variation Limits	0,56 / 0,76	0,20 / 0,28	1,98 /2,58	0,45 / 0,59	0,17 / 0,27	2,37 / 3,26
	CV%	7,39	8,61	6,64	5,69	9,95	6,03

Km, Kw = seed sphericity indices; If= shape index; SD= standard deviation; CV %= coefficient of variability

The sphericity index Km averaged between 0.55 mm at *Marele Alb* and 0, 67 mm at *P3* in 2021, and between 0.51 mm at P3 and 0.61 mm at *Coroana Prințului* and *D19* in 2022.

The results obtained are comparable to those obtained by KALINIEWICZ et al. (2014) respectively 0.44- 0.79 mm.

As for the sphericity index Kw, it showed in 2021 an average value between 0.20 mm at *Marele Alb* and 0.24 mm at *Coroana Prințului* and *P3*, and in 2022 between 0.17 mm at *Tudor* and 0.25 mm at *Coroana Prințului*. In the literature KALINIEWICZ et al. (2014) mention a value of the sphericity index Kw between 0.087 and 0.256 mm.

The shape index of the analyzed pumpkin seeds showed the highest average value in 2021 in the variety *Marele Alb*(2.69 mm) and in 2022 a value of 2.77 mm in the seeds of genotype *P3*.

Table 4 shows some results on protein, oil and moisture content of the analysed pumpkin seeds in 2022. Thus we can observe that moisture had the lowest average value of 4.00% in genotype *D19*, with variation limits ranging from 3, 90% to 4.10% , and the highest value of 5.87% in genotype *P3*.

The results obtained are lower than those obtained DEVI et al., 2018 respectively 5.53% moisture and 28.90% protein.

Protein content had an average value ranging from 10.49% in *Coroana Prințului* variety to 21.50% in *Tudor* variety, with limits of variation between 10.30% in *Coroana Prințului* variety and 21.60% in *Tudor* variety. MONTESANA et al. claims in 2018 that pumpkin seeds have a content of 33.92% protein and 29.00% lipids.

According to the literature the oil content of pumpkin seeds can be influenced by variety or genotype (KUKEERA et al., 2015).

Thus the oil content in the studied varieties and genotypes, recorded the lowest average value of 19.40 % of genotype *D19* and the highest to *Tudor* variety, respectively 21.93%.

Table 4.Chemical composition of pumpkin seeds from varieties and genotypes studied in 2022.

Variety/ Genotype	Moisture %			Protein %			Oil %		
	Mean ± SD	Variation Limits	CV %	Mean ± SD	Variation Limits	CV %	Mean ± SD	Variation Limits	CV %
Marele alb	4,73 ± 0,49	4,40 / 5,30	10,42	14,10 ± 1,31	12,60 /15,00	9,27	21,37 ± 0,08	21,30 /21,45	0,36
Coroana prințului	4,39 ± 0,10	4,30 /4,50	2,31	10,49 ± 0,27	10,30 /10,80	2,58	20,27 ± 0,21	20,10 / 20,50	1,03
Tudor	4,57 ± 0,35	4,20 / 4,90	7,69	21,50 ± 0,10	21,40 / 21,60	0,47	21,93 ± 0,93	20,90 / 22,70	4,24
D19	4,00 ±0,10	3,90 / 4,10	2,50	14,57 ± 0,51	14,00 / 15,00	3,52	19,40 ± 0,20	19,20 / 19,60	1,03
P1	4,73 ± 0,65	4,10 / 5,40	13,75	13,70 ± 1,21	13,00 / 15,00	8,85	20,10 ± 0,69	19,30 /20,50	3,45
P3	5,87 ± 0,25	5,60 / 6,10	4,29	11,33 ± 0,71	10,70 /12,10	6,26	20,17 ± 0,35	19,80 / 20,50	1,74

SD= standard deviation; CV %= coefficient of variability

Figure 2. Pumpkin seeds from D19 genotype

The lowest coefficient of variability of 0.36% was recorded for the oil content of the variety *Marele Alb*, and the highest of 13.75% for the genotype *P1*.

The values recorded in the analyzed pumpkin seeds are lower than those reported by BWADE et al., 2013 (27.83%) and MABALEHA et al., 2007 in *Cucurbita pepo* L (52.80%) and *Cucurbita maxima* Duch. Seeds (55.80%).
The oil content of agricultural products, provides information regarding the processability of fruits and seeds. Thus according to the literature, pumpkin seeds with an oil content higher than 17% are considered oil seeds and can be used in the oil industry (BWADE et al., 2013).

CONCLUSIONS

From the analysis of the results obtained, it is found that there is a large variability in the physical characteristics of pumpkin seeds, both within the varieties and genotypes studied and from year to year.
The high oil content (19.40-21.93%) of pumpkin seeds from genotypes and varieties studied at RDSPCS Dăbuleni, proves to us that pumpkin can also be cultivated for the oil industry.

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