LOCALNUTLEG project is part of the PRIMA programme supported by the European Union's Horizon 2020 research and innovation programme

REPORT FOR THE CHEMICAL AND NUTRITIONAL QUALITY OF DIFFERENT PUMPKIN VARIETIES

DELIVERABLE 1.5

PulpIng

Developing of **Pu**mpkin **Pulp** Formulation using a Sustainable **Integ**rated Strategy

Index

Document Information

Deliverable Number	1.5
Deliverable name	Report for the chemical and nutritional quality of different pumpkin varieties
Contributing WP	WP1: Defining agronomic conditions for pumpkin production
Contractual delivery date	M24, August 2022
Actual delivery date	M40, December 2023
Requested delivery date	August 2023
Dissemination level	Public
Responsible partner	UTH
Reviewers	All partners
Version	1

1. Summary

The PulpIng project aims to develop a high-quality pumpkin pulp product enriched with value-added compounds from pumpkin by-products. This initiative promotes sustainability and an integrative approach. The main objective of WP1 is to evaluate the quality of the best cultivars and local varieties based on various parameters such as proximal composition, free sugars, fatty acids, and physicochemical characteristics (pH and color). This report pertains to WP1 deliverable D1.5 “Report for the chemical and nutritional quality of different pumpkin varieties”. It encompasses the evaluation of the proximal composition, chemical, and physicochemical characterization of different genotypes of pumpkin pulp from Greece, Egypt, and Tunisia, with the aim of determining the quality of each one.

2. Description of work

Following Task 1.4, we conducted an evaluation and comparison of the quality of various cultivars and local pumpkin varieties. The assessment focused on agronomic performance and several key parameters, including proximate composition, levels of free sugars, fatty acids, and pH and colour as physical characteristics. To determine the proximate composition, we adhered to the Official Methods of Analysis of the international AOAC. This involved measuring protein content, crude fat, crude fibers, ash, carbohydrate content, and energy content. For the evaluation of fatty acids and sugars, chromatography techniques were employed. Fatty acids were analyzed using GC coupled to a flame ionization detector, while HPLC coupled to a refractive index detector was utilized for sugar evaluation. Lastly, we assessed the physicochemical parameters of colour and pH of the pumpkin pulp. Chromatic analysis in the CIELAB colour space was employed, measuring L* (lightness), a* (redness), and b* (yellowness) to obtain the palette of tones and the chroma values of the different pumpkin genotypes.

2.1. Goal

The goal of this study is to comprehensively evaluate and compare the quality of diverse pumpkin cultivars and local varieties. The assessment focuses on their agronomic performance and various essential parameters. By employing standardized methods, including chromatography techniques and chromatic analysis, we aim to gain valuable insights into the proximate composition, fatty acids, sugars, and physicochemical attributes of the pumpkin pulp. Ultimately, this research aims to identify superior pumpkin genotypes for potential future development and utilization in sustainable and high-quality pumpkin pulp products.

3. Results

The fruit pulp of the different genotypes of pumpkin cultivated in Greece, Egypt and Tunisia were characterized in terms of their proximate composition, following the Official Methods of Analysis of AOAC international, of their chemical composition, more specifically the fatty acids content (by GC coupled to an ionization flame detector) and the free sugars content (HPLC coupled to a refraction index detector), and of their physico-chemical parameters (colour and pH). For that purpose, the chromatic analysis on colour spaces was used (CIELAB color space) measuring the L* (lightness), a* (redness), and b* (yellowness) parameters to obtain the hue palette and Chroma values. For the pH evaluation, 0.1 g of crushed samples were diluted in 20 mL of distilled water.

3.1 Samples from Greece

First Harvest

The evaluated Greek genotypes from the first harvest are listed in Table 1 along with the respective code. Table 2 presents the results of fat, protein, ash, energy, carbohydrates, and fiber content of the pulps. All pulp samples revealed carbohydrates as the major macronutrients, with contents of about 67-86%, followed by protein (about 8-21%), and fat (about 0.4-1.1%). The ash content ranged from about 3.5 to 11% and the fibers from about 12 to 27%.

Table 1. Variety name of pumpkin cultivated in Greece according to the code and part of the fruit.

Code	Pulp
1	V2 (Landrace from the region of Trikala) Turbinate
2	V5 (Local landrace “Leuka Melitis) Flattened
3	V1 (Fytro FS-243) UTH
4	V2 (Landrace from the region of Trikala) Cylindrical
5	V4 (Local landrace “Nychaki”) Cylindrical
6	V5 (Local landrace “Leuka Melitis) Round
7	V7 (Local landrace from the region of Lakonia) Pyriform
8	V7 (Local landrace from the region of Lakonia) Flattened
9	V9 (Local landrace “Makedonika prasina") Cylindrical
10	Voutirato
11	V9 (Local landrace “Makedonika prasina") Round
12	V10 (Local landrace from the region of Laconia)
13	V8 (Local landrace from the region of Lakonia)
14	V1 (Fytro FS-243) GFV
15	V3 (Big Max)
16	V6 (Local landrace from the region of Lakonia)
17	V4 (Local landrace “Nychaki”) Round

Table 2. Proximate composition of the pulp of 17 different pumpkin genotypes from Greece (%).

Variety	Fat	Protein	Ash	Carbohydrates	Fibers	Energy
1	1.12 ± 0.06	13.7 ± 0.4	6.07 ± 0.04	54.9 ± 0.7	24.27 ± 0.02	332.8 ± 0.3
2	0.58 ± 0.03	12.61 ± 0.05	5.126 ± 0.006	67.3 ± 0.1	14.34 ± 0.04	353.70 ± 0.07
3	0.83 ± 0.04	12.6 ± 0.6	4.511 ± 0.009	69.1 ± 0.7	13.0 ± 0.1	360.1 ± 0.4
4	0.645 ± 0.002	12.9 ± 0.1	7.1 ± 0.1	59.2 ± 0.8	20.2 ± 0.8	334.6 ± 1.2
5	0.64 ± 0.03	8.6 ± 0.1	7.1 ± 0.1	62.6 ± 0.2	21.1 ± 0.2	332.5 ± 0.1
6	0.55 ± 0.03	9.9 ± 0.3	3.5 ± 0.1	72.2 ± 0.6	13.8 ± 0.4	361.0 ± 0.1
7	0.92 ± 0.04	14.1 ± 0.1	7.49 ± 0.03	61.9 ± 0.6	15.5 ± 0.5	343.6 ± 0.6
8	0.70 ± 0.03	11.9 ± 0.1	7.27 ± 0.06	67.26 ± 0.6	12.8 ± 0.2	348.76 ± 0.05
9	0.73 ± 0.03	21.4 ± 0.6	10.95 ± 0.05	44.5 ± 0.2	22.4 ± 0.5	315.05 ± 0.96
10	1.12 ± 0.02	8.0 ± 0.3	6.71 ± 0.04	64.0 ± 0.4	20.1 ± 0.2	338.52 ± 0.34
11	0.65 ± 0.03	20.3 ± 0.3	10.19 ± 0.07	41.4 ± 0.4	27.4 ± 0.8	307.7 ± 1.5
12	0.73 ± 0.03	9.9 ± 0.2	9.3 ± 0.1	53.7 ± 0.2	26.3 ± 0.1	313.8 ± 0.1
13	0.76 ± 0.03	11.3 ± 0.4	7.29 ± 0.02	58.0 ± 1.3	22.7 ± 0.9	329.4 ± 1.6
14	0.85 ± 0.04	11.9 ± 0.3	4.16 ± 0.09	68.9 ± 0.2	14.16 ± 0.03	359.3 ± 0.1
15	0.45 ± 0.02	18.07 ± 0.03	7.7 ± 0.2	49.0 ± 0.2	24.7 ± 0.5	321.85 ± 0.02
16	1.17 ± 0.02	13.4 ± 0.3	6.98 ± 0.05	60.27 ± 0.03	18.2 ± 0.3	341.5 ± 0.8
17	0.38 ± 0.02	17.46 ± 0.04	9.08 ± 0.07	51.1 ± 0.3	21.9 ± 0.4	321.7 ± 0.6

The fatty acids and free sugar contents are shown in Table 3 and 4, respectively. Regarding free sugars, two predominant profiles were traced: one rich in fructose and glucose and low in sucrose, and another one with opposite prevalence (Figure 1). Considerable contents of trehalose and raffinose were also found in all samples. In fatty acids, the C16:0, C18:2n6c, and C18:3n3 were the most abundant ones in all samples. The varieties 4 and 5 are rich in SFA (about 80% of the total), due the predominant content of C16:0, while the other samples showed higher levels of PUFA, ranging from 46 to 64% of total.

Table 3. Free sugar content of the pulp of 17 different pumpkin genotypes from Greece (g/100g dw).

Variety	Fructose	Glucose	Sucrose	Trehalose	Raffinose	Total
1	9.7 ± 0.9	21.5 ± 0.3	1.4 ± 0.2	0.45 ± 0.02	0.29 ± 0.03	33 ± 1
2	3.790 ± 0.002	4.8 ± 0.1	3.6 ± 0.2	0.408 ± 0.005	0.18 ± 0.01	12.8 ± 0.4
3	2.42 ± 0.03	2.50 ± 0.08	12.2 ± 0.4	0.46 ± 0.03	0.0579 ± 0.0003	17.7 ± 0.5
4	10.0 ± 0.3	22 ± 1	0.9 ± 0.2	0.67 ± 0.02	0.09 ± 0.02	34 ± 1
5	7.854 ± 0.001	18.6 ± 0.8	6.4 ± 0.7	0.51 ± 0.06	0.13 ± 0.04	33 ± 2
6	2.55 ± 0.07	4.66 ± 0.05	4.91 ± 0.05	0.46 ± 0.01	0.06 ± 0.05	12.6 ± 0.1
7	2.8 ± 0.2	3.1 ± 0.2	14.0 ± 0.5	0.56 ± 0.02	0.05 ± 0.01	20.4 ± 0.8
8	3.3 ± 0.2	4.7 ± 0.2	14.0 ± 0.7	0.50 ± 0.02	0.057 ± 0.008	23 ± 1
9	8.23 ± 0.04	12.2 ± 0.5	2.2 ± 0.1	0.26 ± 0.04	0.16 ± 0.02	23.1 ± 0.3
10	8.9 ± 0.4	26.9 ± 0.9	1.50 ± 0.06	0.48 ± 0.04	0.20 ± 0.03	38.0 ± 0.5
11	4.9 ± 0.1	4.3 ± 0.4	10.4 ± 0.3	0.40 ± 0.06	0.16 ± 0.03	20.2 ± 0.9
12	6.7 ± 0.4	19.3 ± 0.8	3.48 ± 0.08	0.3273 ± 0.0007	0.108 ± 0.004	30 ± 1
13	7.4 ± 0.4	19 ± 2	4.0 ± 0.2	0.37 ± 0.02	0.25 ± 0.02	31 ± 1
14	1.939 ± 0.005	2.0 ± 0.2	20.238 ± 0.001	0.6 ± 0.1	0.108 ± 0.002	24.9 ± 0.3
15	6.57 ± 0.02	9.6 ± 0.4	2.6 ± 0.3	0.23 ± 0.02	0.23 ± 0.03	19.2 ± 0.8
16	8.18 ± 0.04	20.33 ± 0.06	1.12 ± 0.06	0.50 ± 0.03	0.27 ± 0.02	30.41 ± 0.09
17	6.6 ± 0.3	10.2 ± 0.6	3.47 ± 0.01	0.47 ± 0.03	0.24 ± 0.03	20.9 ± 0.9

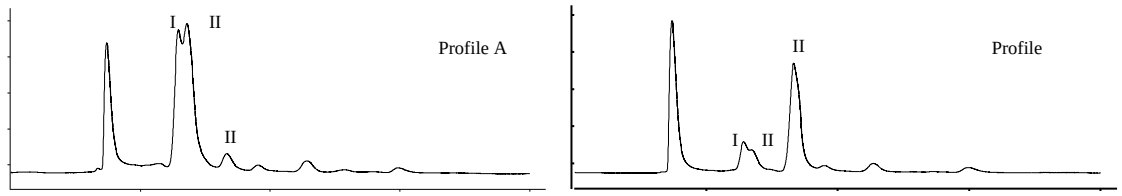

Figure 1. Profile A, rich in fructose (I) and glucose (II); Profile B, rich in sucrose (III).

Table 4. Fatty acids of the pulp of the different pumpkin genotypes (%)

Compound	1	2	3	4	5	6	7	8	9
C8:0	-	-	-	0.264 ± 0.006	0.24 ± 0.01	-	-	-	0.141 ± 0.001
C10:0	-	-	0.137 ± 0.001	0.1775 ± 0.0007	0.143 ± 0.002	0.0720 ± 0.0000	0.120 ± 0.001	0.070 ± 0.002	0.100 ± 0.001
C11:0	-	-	-	-	-	-	-	-	-
C12:0	0.219 ± 0.03	0.25 ± 0.01	1.893 ± 0.004	0.49 ± 0.02	0.61 ± 0.01	0.330 ± 0.001	1.49 ± 0.05	1.21 ± 0.04	0.342 ± 0.004
C13:0	-	0.058 ± 0.001	-	-	-	0.0935 ± 0.0007	-	-	-
C14:0	1.22 ± 0.03	0.90 ± 0.01	1.898 ± 0.007	1.84 ± 0.03	1.5980 ± 0.0000	1.053 ± 0.006	1.55 ± 0.04	1.13 ± 0.05	1.29 ± 0.02
C15:0	0.117 ± 0.004	-	0.079 ± 0.004	0.53 ± 0.01	0.648 ± 0.007	0.895 ± 0.0007	0.1095 ± 0.0007	0.0775 ± 0.0007	0.445 ± 0.005
C15:1	-	-	-	-	-	-	-	-	-
C16:0	20.9 ± 0.6	26.97 ± 0.03	28.9 ± 0.2	61.4 ± 0.5	63.4 ± 0.2	26.3 ± 0.1	25.67 ± 0.01	22.3 ± 0.2	26.49 ± 0.05
C16:1	0.269 ± 0.006	0.45 ± 0.01	0.42 ± 0.02	0.586 ± 0.006	0.53 ± 0.01	0.388 ± 0.002	0.283 ± 0.009	0.36 ± 0.02	0.520 ± 0.004
C17:0	0.224 ± 0.002	0.222 ± 0.001	0.390 ± 0.002	6.39 ± 0.05	7.01 ± 0.04	0.237 ± 0.001	0.602 ± 0.004	0.349 ± 0.001	0.350 ± 0.004
C17:1	0.107 ± 0.002	0.132 ± 0.001	0.182 ± 0.006	0.84 ± 0.01	0.65 ± 0.01	0.1465 ± 0.0007	0.377 ± 0.009	-	0.0945 ± 0.0007
C18:0	1.85 ± 0.05	2.25 ± 0.06	2.5 ± 0.1	4.89 ± 0.07	5.30 ± 0.02	2.02 ± 0.01	4.2 ± 0.1	3.0 ± 0.1	2.3 ± 0.1
C18:1n9c	14.1 ± 0.1	8.6 ± 0.2	12.1 ± 0.3	8.4 ± 0.2	4.95 ± 0.05	6.53 ± 0.03	13.30 ± 0.02	8.9 ± 0.4	5.86 ± 0.01
C18:2n6c	34.0 ± 0.8	27.0 ± 0.1	22.9 ± 0.2	5.1 ± 0.1	5.9 ± 0.2	32.2 ± 0.2	24.8 ± 0.1	29.8 ± 0.2	31.97 ± 0.04

C18:3n6	0.080 ± 0.002	0.216 ± 0.006	0.162 ± 0.006	-	0.54 ± 0.03	-	-	-	-
C18:3n3	24.9 ± 0.4	29.81 ± 0.02	25.9 ± 0.3	0.512 ± 0.001	0.60 ± 0.02	27.3 ± 0.4	23.42 ± 0.07	29.53 ± 0.08	25.73 ± 0.07
C20:0	-	-	-	1.03 ± 0.03	0.75 ± 0.03	0.213 ± 0.001	0.311 ± 0.003	0.25 ± 0.01	0.335 ± 0.001
C20:1	-	-	-	-	-	-	-	-	0.542 ± 0.002
C21:0	-	-	-	-	-	0.1345 ± 0.0007	0.184 ± 0.002	-	0.1555 ± 0.0007
C20:3n6	-	-	-	-	-	-	-	-	0.1355 ± 0.0007
C22:0	0.811 ± 0.004	1.16 ± 0.04	0.68 ± 0.02	3.23 ± 0.01	2.02 ± 0.02	1.089 ± 0.006	1.16 ± 0.01	1.13 ± 0.05	0.838 ± 0.003
C20:5n3	-	-	0.099 ± 0.003	-	-	-	-	-	-
C22:1	-	-	-	-	-	-	-	-	0.435 ± 0.002
C22:2	0.163 ± 0.004	0.152 ± 0.006	0.264 ± 0.004	-	0.246 ± 0.008	0.28 ± 0.01	0.536 ± 0.006	0.240 ± 0.007	0.225 ± 0.001
C22:6n3					0,291 ± 0,006				
C23:0	0.33 ± 0.01	0.385 ± 0.008	0.368 ± 0.001	0.98 ± 0.04	0.87 ± 0.03	0.37 ± 0.01	0.539 ± 0.006	0.47 ± 0.02	0.537 ± 0.002
C24:0	0.78 ± 0.03	1.38 ± 0.01	1.14 ± 0.01	3.4 ± 0.2	3.696 ± 0.008	1.141 ± 0.006	1.36 ± 0.01	1.25 ± 0.05	1.136 ± 0.004
C24:1	-	-	-	-	-	-	-	-	0.0875 ± 0.0007
SFA	26.4 ± 0.5	33.58 ± 0.02	38.0 ± 0.3	84.6 ± 0.4	86.3 ± 0.2	33.1 ± 0.2	37.3 ± 0.2	31.2 ± 0.3	34.41 ± 0.03
MUFA	14.5 ± 0.1	9.2 ± 0.2	12.7 ± 0.2	9.8 ± 0.3	6.13 ± 0.07	7.07 ± 0.04	13.96 ± 0.00	9.2 ± 0.4	7.533 ± 0.006
PUFA	59.1 ± 0.4	57.2 ± 0.2	49.3 ± 0.5	5.6 ± 0.1	7.6 ± 0.3	59.8 ± 0.2	48.8 ± 0.2	59.59 ± 0.07	58.05 ± 0.04

Compound	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
C8:0	-	-	-	-	-	-	-	-
C10:0	-	0.1125 ± 0.0007	-	0.0680 ± 0.0000	0.0895 ± 0.0007	0.0830 ± 0.0000	-	-
C11:0	-	-	-	-	-	-	-	-
C12:0	0.125 ± 0.004	0.36 ± 0.01	-	0.259 ± 0.003	0.908 ± 0.006	0.500 ± 0.004	0.2135 ± 0.0007	0.3050 ± 0.0000
C13:0	-	0.120 ± 0.006	-	-	-	0.1020 ± 0.0000	0.0940 ± 0.0000	-
C14:0	0.83 ± 0.04	1.21 ± 0.01	0.748 ± 0.008	0.83 ± 0.01	0.96 ± 0.02	1.0505 ± 0.0007	0.866 ± 0.001	0.7960 ± 0.0000
C15:0	0.133 ± 0.006	0.1945 ± 0.0007	0.3455 ± 0.0007	0.290 ± 0.003	0.111 ± 0.004	0.1690 ± 0.0000	0.1350 ± 0.0000	0.190 ± 0.001
C15:1	-	-	-	-	-	-	-	-
C16:0	19.6 ± 0.5	27.3 ± 0.1	25.982 ± 0.007	30.2 ± 0.1	24.15 ± 0.09	36.46 ± 0.04	20.88 ± 0.03	29.8 ± 0.2
C16:1	0.55 ± 0.02	0.231 ± 0.008	0.37 ± 0.01	0.50 ± 0.01	0.238 ± 0.006	0.295 ± 0.004	0.61 ± 0.02	0.50 ± 0.02
C17:0	0.199 ± 0.009	0.26 ± 0.01	0.423 ± 0.001	0.93 ± 0.01	0.3525 ± 0.0007	1.23 ± 0.04	0.1520 ± 0.0000	0.969 ± 0.007
C17:1	0.151 ± 0.006	-	0.1805 ± 0.0007	0.1355 ± 0.0007	0.1075 ± 0.0007	0.3770 ± 0.0000	0.1250 ± 0.0000	-
C18:0	1.54 ± 0.06	1.64 ± 0.04	2.37 ± 0.04	2.53 ± 0.05	3.202 ± 0.005	2.45 ± 0.08	1.568 ± 0.005	2.614 ± 0.008
C18:1n9c	9.46 ± 0.03	1.980 ± 0.006	3.919 ± 0.006	4.720 ± 0.007	14.77 ± 0.03	6.0 ± 0.2	9.57 ± 0.04	7.6 ± 0.2
C18:2n6c	25.09 ± 0.07	33.4 ± 0.1	34.65 ± 0.07	35.78 ± 0.03	24.36 ± 0.06	25.8 ± 0.2	30.12 ± 0.03	28.71 ± 0.08
C18:3n6	-	-	-	-	-	-	-	-
C18:3n3	38.8 ± 0.3	29.59 ± 0.09	28.5 ± 0.1	19.003 ± 0.0007	27.18 ± 0.04	20.4 ± 0.1	32.87 ± 0.04	24.48 ± 0.02
C20:0	0.235 ± 0.008	0.37 ± 0.01	0.2315 ± 0.0007	0.289 ± 0.001	0.309 ± 0.004	0.3790 ± 0.0000	0.1840 ± 0.0000	-
C20:1	-	-	-	-	-	-	0.2015 ± 0.0007	-
C21:0	-	0..2135 ± 0.0007	-	0.241 ± 0.001	0.232 ± 0.001	-	0.1455 ± 0.0007	-
C20:3n6	-	-	-	-	-	-	-	-
C22:0	1.26 ± 0.05	0.973 ± 0.005	0.653 ± 0.002	1.18 ± 0.02	1.00 ± 0.04	1.11 ± 0.03	0.876 ± 0.009	1.26 ± 0.04

C20:5n3	-	-	-	-	0.1040 ± 0.0000	-	-	-
C22:1	-	-	-	-	-	0.166 ± 0.006	-	0.602 ± 0.009
C22:2	0.150 ± 0.004	0.1840 ± 0.0000	0.1775 ± 0.0007	0.334 ± 0.002	0.337 ± 0.001	0.223 ± 0.002	0.141 ± 0.005	-
C22:6n3								
C23:0	0.598 ± 0.006	0.615 ± 0.001	0.360 ± 0.001	0.438 ± 0.002	0.482 ± 0.001	0.519 ± 0.009	0.39 ± 0.01	0.427 ± 0.006
C24:0	1.28 ± 0.03	1.1905 ± 0.0007	0.811 ± 0.003	2.3 ± 0.1	1.106 ± 0.002	2.63 ± 0.06	0.854 ± 0.008	1.67 ± 0.03
C24:1	-	-	-	-	-	-	-	-
SFA	25.8 ± 0.4	34.6 ± 0.2	32.20 ± 0.02	39.53 ± 0.02	32.9 ± 0.1	46.7 ± 0.1	26.36 ± 0.03	38.8 ± 0.09
MUFA	10.157 ± 0.008	2.211 ± 0.003	4.46 ± 0.01	5.36 ± 0.02	15.11 ± 0.03	6.9 ± 0.2	10.51 ± 0.05	8.7 ± 0.2
PUFA	64.0 ± 0.4	63.2 ± 0.2	63.34 ± 0.03	55.12 ± 0.03	52.0 ± 0.1	46.4 ± 0.3	63.13 ± 0.02	53.2 ± 0.1

The colour and pH parameters are shown in Table 5.

Table 5. Colour parameters and pH of the pulp of 17 different pumpkin genotypes from Greece (%; water pH: 5.26 ± 0.02).

Variety	pH	*L**	*a**	*b**	Color (RGB)
1	6.29 ± 0.01	81.6 ± 0.3	5.6 ± 0.1	58 ± 1	
2	6.364 ± 0.004	86.35 ± 0.07	-4.47 ± 0.04	37.44 ± 0.02	
3	6.4033 ± 0.0006	81.34 ± 0.04	5.82 ± 0.02	54.52 ± 0.03	
4	6.235 ± 0.004	85.7 ± 0.2	-3.51 ± 0.05	27.6 ± 0.1	
5	6.34 ± 0.01	79.6 ± 0.3	-0.8 ± 0.1	33.7 ± 0.8	
6	6.924 ± 0.005	86.36 ± 0.01	-2.41 ± 0.05	37.68 ± 0.03	
7	6.144 ± 0.004	87.1 ± 0.2	1.02 ± 0.04	43.3 ± 0.3	
8	6.03 ± 0.03	85.6 ± 0.6	1.20 ± 0.03	46.38 ± 0.04	
9	5.997 ± 0.004	81.4 ± 0.1	0.74 ± 0.01	43.57 ± 0.04	
10	6.522 ± 0.004	80.0 ± 0.2	5.810 ± 0.000	58.7 ± 0.2	
11	5.822 ± 0.001	76.6 ± 0.1	4.75 ± 0.05	51.91 ± 0.06	
12	6.251 ± 0.005	83.95 ± 0.06	-2.62 ± 0.02	36.24 ± 0.04	
13	6.49 ± 0.02	85.43 ± 0.05	-1.18 ± 0.02	30.79 ± 0.06	
14	6.35 ± 0.01	79.9 ± 0.3	11.4 ± 0.1	55.4 ± 0.6	
15	5.93 ± 0.02	74 ± 1	3.7 ± 0.5	39 ± 2	
16	6.345 ± 0.009	79.3 ± 0.3	5.8 ± 0.4	60.2 ± 0.8	
17	6.06 ± 0.02	75 ± 1	2.2 ± 0.2	37 ± 1	

Second Harvest

The Greek genotypes assessed during the second harvest are documented in Table 6, each accompanied by a specific code. Table 7 shows the findings concerning fat, protein, ash, energy, and carbohydrate content. Across all pulp samples, carbohydrates emerged as the primary macronutrient, constituting approximately 70-82% of the content, followed by protein (approximately 11-19%), and fat (approximately 0.181-0.9%). The ash content varied, ranging from 4.8% to 10.2%.

Table 6. Variety name of the pumpkin grown in the second harvest in Greece according to the code and part of the fruit.

Code	Pulp
18	V2 (Landrace from the region of Trikala) Turbinate
19	V5 (Local landrace “Leuka Melitis)
20	V1 (Fytro FS-243) UTH
21	V2 (Landrace from the region of Trikala) Cylindrical
22	V4 (Local landrace “Nychaki”) Cylindrical
23	V5 (Local landrace “Leuka Melitis) Round
24	V7 (Local landrace from the region of Lakonia) Pyriform
25	V7 (Local landrace from the region of Lakonia) Flattened
26	V9 (Local landrace “Makedonika prasina") Cylindrical
27	Voutirato
28	V9 (Local landrace “Makedonika prasina") Round
29	V10 (Local landrace from the region of Laconia)
30	V8 (Local landrace from the region of Lakonia)
31	V1 (Fytro FS-243) GFV
32	V3 (Big Max)
33	V6 (Local landrace from the region of Lakonia)
34	V4 (Local landrace “Nychaki”) Round

Table 7. Proximate composition of the pulp of 17 different pumpkin genotypes from Greece (%).

Variety	Fat	Protein	Ash	Carbohydrates	Energy
18	0.60 ± 0.02	15.9 ± 0.3	5.9 ± 0.3	77.6 ± 0.5	379 ± 1
19	0.38 ± 0.01	13.6 ± 0.5	7.0 ± 0.1	79.1 ± 0.4	374.1 ± 0.3
20	0.32 ± 0.01	13.4 ± 0.4	4.95 ± 0.07	81.3 ± 0.5	381.8 ± 0.2
21	0.181 ± 0.009	15.3 ± 0.5	8.1 ± 0.3	76.4 ± 0.1	369 ± 1
22	0.90 ± 0.04	14.9 ± 0.2	5.4 ± 0.2	78.78 ± 0.07	382.7 ± 0.8
23	0.69 ± 0.02	12.3 ± 0.2	6.5 ± 0.3	80.57 ± 0.09	377.6 ± 0.9
24	0.52 ± 0.03	16.3 ± 0.3	6.2 ± 0.2	77.0 ± 0.1	377.8 ± 0.5
25	0.64 ± 0.03	12.8 ± 0.4	8.1 ± 0.4	78.5 ± 0.1	371 ± 2
26	0.38 ± 0.02	11.4 ± 0.4	5.7 ± 0.3	82.6 ± 0.7	379 ± 1
27	0.86 ± 0.03	14.5 ± 0.1	5.3 ± 0.1	79.354 ± 0.009	383.3 ± 0.7
28	0.73 ± 0.04	13.7 ± 0.1	10.2 ± 0.4	75.3 ± 0.3	363 ± 1
29	0.63 ± 0.03	11.95 ± 0.08	6.5 ± 0.1	80.9 ± 0.1	377.1 ± 0.5
30	0.41 ± 0.02	10.6 ± 0.4	6.59 ± 0.01	82.5 ± 0.4	375.68 ± 0.05
31	0.75 ± 0.04	11.6 ± 0.4	6.9 ± 0.2	80.7 ± 0.6	376.1 ± 0.7
32	0.54 ± 0.03	14.6 ± 0.4	6.6 ± 0.2	78.2 ± 0.6	376.3 ± 0.7
33	0.81 ± 0.04	19.1 ± 0.1	9.77 ± 0.09	70.29 ± 0.05	365.0 ± 0.6
34	0.8527 ± 0.0009	12.2 ± 0.2	4.8 ± 0.2	82.08 ± 0.06	384.9 ± 0.6

The analyses of fatty acids and free sugars are presented in Tables 8 and 9, respectively. In the case of free sugars, the first harvest yielded two predominant profiles: one characterized by high fructose and glucose content but low sucrose levels, and another with the opposite prevalence. All samples also exhibited considerable trehalose and raffinose contents.

Regarding fatty acids, C16:0, C18:2n6c, and C18:3n3 were the most abundant across all samples. Varieties 24 and 25 demonstrated richness in Saturated Fatty Acids (SFA), accounting for approximately 80% of the total, primarily due to the prevalence of C16:0 content. On the other

hand, the remaining samples exhibited higher levels of Polyunsaturated Fatty Acids (PUFA), ranging from 46 to 60% of the total.

Table 8. Free sugar content of the pulp of 17 different pumpkin genotypes from Greece (g/100g dw).

Variety	Fructose	Glucose	Sucrose	Trehalose	Raffinose	Total
18	21.8 ± 0.2	15.5 ± 0.3	2.16 ± 0.01	0.63 ± 0.03	0.267 ± 0.003	40.3 ± 0.5
19	24.4 ± 0.6	24.7 ± 0.6	2.70 ± 0.07	1.10 ± 0.04	1.12 ± 0.01	54 ± 1
20	30.48 ± 0.06	25.1 ± 0.2	1.20 ± 0.01	1.18 ± 0.02	0.73 ± 0.02	58.68 ± 0.07
21	8.2 ± 0.2	8.2 ± 0.2	26.4 ± 0.5	0.86 ± 0.04	0.64 ± 0.02	44.4 ± 0.9
22	21.1 ± 0.4	19.0 ± 0.3	2.37 ± 0.06	1.25 ± 0.04	0.64 ± 0.01	44.4 ± 0.7
23	6.7 ± 0.2	3.01 ± 0.09	32 ± 1	1.36 ± 0.04	0.73 ± 0.02	44 ± 2
24	14.8 ± 0.4	9.6 ± 0.3	18.2 ± 0.5	0.71 ± 0.05	0.70 ± 0.03	44 ± 1
25	26.6 ± 0.4	19.0 ± 0.3	1.29 ± 0.02	0.95 ± 0.04	0.24 ± 0.01	48.1 ± 0.8
26	23.2 ± 0.7	71.0 ± 0.4	13.1 ± 0.3	1.46 ± 0.05	0.145 ± 0.004	55 ± 1
27	4.50 ± 0.08	1.86 ± 0.06	39.95 ± 0.04	1.25 ± 0.05	0.60 ± 0.03	48.2 ± 0.2
28	24.8 ± 0.2	9.465 ± 0.004	2.26 ± 0.02	1.024 ± 0.008	0.365 ± 0.005	38.0 ± 0.2
29	24.6 ± 0.4	14.7 ± 0.3	5.373 ± 0.002	1.67 ± 0.02	0.34 ± 0.01	46.7 ± 0.6
30	26.3 ± 0.3	18.35 ± 0.09	3.87 ± 0.05	1.38 ± 0.01	1.191 ± 0.008	50.1 ± 0.3
31	23.0 ± 0.2	10.0 ± 0.3	12.2 ± 0.1	1.36 ± 0.05	0	46.6 ± 0.47
32	26.8 ± 0.8	13.1 ± 0.4	1.74 ± 0.05	1.49 ± 0.047	0.292 ± 0.005	43 ± 1
33	19.8 ± 0.9	4.4 ± 0.2	1.23 ± 0.02	0.94 ± 0.05	0.57 ± 0.02	27 ± 1
34	7.18 ± 0.01	2.78 ± 0.02	36.7 ± 0.1	1.52 ± 0.04	0.55 ± 0.02	48.8 ± 0.2

Table 9. Fatty acids of the pulp of the different pumpkin genotypes (%)

Compound	18	19	20	21	22	23	24	25	26
C6:0	-	-	-	-	-	-	-	0.434 ± 0.003	-
C8:0	-	-	-	-	-	-	-	0.454 ± 0.003	-
C10:0	-	-	-	-	-	-	-	0.571 ± 0.003	-
C12:0	-	-	-	1.16 ± 0.02	-	1.998 ± 0.005	0.744 ± 0.000	0.965 ± 0.005	0.540 ± 0.000
C14:0	2.13 ± 0.03	2.719 ± 0.002	1.01 ± 0.01	2.27 ± 0.07	2.821 ± 0.004	1.621 ± 0.007	2.062 ± 0.000	1.8075 ± 0.0007	0.9545 ± 0.0007
C15:0	-	-	-	1.01 ± 0.02	-	-	0.853 ± 0.000	0.84 ± 0.02	0.506 ± 0.004
C16:0	25 ± 0.3	26.71 ± 0.02	28.4 ± 0.3	30.56 ± 0.09	29.71 ± 0.06	35.1 ± 0.1	37.16 ± 0.04	30.3 ± 0.1	31.186 ± 0.006
C17:0	-	-	-	0.72 ± 0.02	-	-	0.755 ± 0.004	0.731 ± 0.004	0.701 ± 0.000
C18:0	4.05 ± 0.07	4.12 ± 0.03	3.16 ± 0.03	3.03 ± 0.07	2.88 ± 0.01	3.389 ± 0.008	2.940 ± 0.000	2.59 ± 0.01	2.59 ± 0.04
C18:1n9c	20.77 ± 0.03	12.8 ± 0.2	8.3 ± 0.1	6.64 ± 0.09	10.94 ± 0.02	6.73 ± 0.02	1.869 ± 0.000	2.43 ± 0.01	3.206 ± 0.004
C18:2n6c	31.9 ± 0.1	18.1 ± 0.2	30.2 ± 0.1	35.9 ± 0.2	19.27 ± 0.02	26.55 ± 0.04	29.033 ± 0.006	21.1 ± 0.1	29.41 ± 0.03
C18:3n3	14.781 ± 0.001	32.97 ± 0.07	25.7 ± 0.1	13.19 ± 0.09	32.868 ± 0.005	22.48 ± 0.04	20.97 ± 0.03	29.989 ± 0.009	22.419 ± 0.004
C20:0	-	-	-	1.13 ± 0.02	-	-	-	1.086 ± 0.006	0.863 ± 0.000
C21:0	-	-	-	-	-	-	-	0.410 ± 0.003	0.430 ± 0.000
C22:0	0.94 ± 0.02	0.940 ± 0.009	1.402 ± 0.006	1.392 ± 0.002	0.74 ± 0.03	0.909 ± 0.002	1.087 ± 0.000	2.29 ± 0.01	1.5195 ± 0.0007

C23:0	-	0.66 ± 0.02	-	1.03 ± 0.03	-	-	0.777 ± 0.000	1.200 ± 0.006	0.926 ± 0.000
C24:0	-	0.949 ± 0.009	1.95 ± 0.09	1.95 ± 0.07	0.78 ± 0.02	1.267 ± 0.003	1.757 ± 0.000	2.77 ± 0.05	4.748 ± 0.001
SFA	32.5 ± 0.1	36.10 ± 0.03	35.9 ± 0.1	44.2 ± 0.04	36.930 ± 0.004	44.2 ± 0.1	48.13 ± 0.04	46.4 ± 0.1	32.5 ± 0.1
MUFA	20.77 ± 0.03	12.8 ± 0.2	8.3 ± 0.1	6.64 ± 0.09	10.94 ± 0.02	6.73 ± 0.02	1.869 ± 0.000	2.43 ± 0.01	20.77 ± 0.03
PUFA	46.7 ± 0.1	51.1 ± 0.2	55.822 ± 0.000	49.1 ± 0.1	52.14 ± 0.02	49.03 ± 0.08	50.00 ± 0.04	51.1 ± 0.1	46.7 ± 0.1

Compound	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
C12:0	2.362 ± 0.004	-	-	-	1.137 ± 0.001	-	0.829 ± 0.001	1.398 ± 0.001
C13:0	-	-	-	-	-	-	-	-
C14:0	2.128 ± 0.004	0.814 ± 0.001	0.84 ± 0.02	0.645 ± 0.001	1.024 ± 0.001	0.65 ± 0.01	0.846 ± 0.001	1.556 ± 0.001
C15:0	-	0.66 ± 0.03	0.58 ± 0.02	0.593 ± 0.001	-	0.381 ± 0.004	0.552 ± 0.001	0.2665 ± 0.0007
C16:0	23.98 ± 0.03	28.70 ± 0.03	26.1 ± 0.7	27.975 ± 0.006	25.04 ± 0.04	24.3 ± 0.3	31.76 ± 0.04	29.30 ± 0.03
C16:1	-	-	-	-	-	0.754 ± 0.008	-	0.236 ± 0.000
C17:0	-	0.5495 ± 0.0007	-	0.6025 ± 0.0007	0.5595 ± 0.0007	0.260 ± 0.003	0.4635 ± 0.0007	0.521 ± 0.005
C18:0	3.26 ± 0.03	2.041 ± 0.002	2.30 ± 0.02	2.63 ± 0.07	2.98 ± 0.08	1.54 ± 0.08	2.18 ± 0.02	2.5645 ± 0.0007
C18:1n9c	10.28 ± 0.06	1.905 ± 0.001	2.59 ± 0.08	2.19 ± 0.05	3.80 ± 0.08	4.5 ± 0.1	4.51 ± 0.04	6.976 ± 0.009
C18:2n6c	20.3 ± 0.1	26.11 ± 0.02	29.1 ± 0.2	28.71 ± 0.06	20.99 ± 0.05	32.3 ± 0.4	25.70 ± 0.04	24.10 ± 0.02
C18:3n3	27.32 ± 0.04	31.51 ± 0.04	28.8 ± 0.8	26.89 ± 0.03	32.33 ± 0.05	28.49 ± 0.04	26.7 ± 0.1	28.10 ± 0.02
C20:0	-	0.8135 ± 0.0007	-	-	-	-	0.7525 ± 0.0007	0.8565 ± 0.0007
C21:0	-	-	-	-	-	-	-	0.2665 ± 0.0007
C22:0	1.71 ± 0.06	2.125 ± 0.001	2.19 ± 0.07	3.122 ± 0.008	2.652 ± 0.004	2.00 ± 0.02	1.634 ± 0.002	1.309 ± 0.001
C20:5n3	-	-	-	-	2.041 ± 0.004	-	-	-
C22:2	-	-	-	-	1.821 ± 0.003	-	-	-
C23:0	1.604 ± 0.002	1.415 ± 0.001	1.71 ± 0.05	2.131 ± 0.006	1.423 ± 0.002	2.72 ± 0.03	0.916 ± 0.001	0.772 ± 0.000
C24:0	7.02 ± 0.01	3.361 ± 0.004	5.7 ± 0.2	4.52 ± 0.01	4.204 ± 0.006	2.22 ± 0.02	3.193 ± 0.004	1.7715 ± 0.0007
SFA	44.97 ± 0.04	42.1 ± 0.1	40.48 ± 0.02	40 ± 1	42.21 ± 0.05	39.01 ± 0.03	34.1 ± 0.3	43.13 ± 0.04
MUFA	3.206 ± 0.004	10.28 ± 0.06	1.905 ± 0.001	2.59 ± 0.08	2.19 ± 0.05	3.80 ± 0.08	5.2 ± 0.1	4.51 ± 0.04
PUFA	51.83 ± 0.04	47.66 ± 0.08	57.62 ± 0.02	58 ± 1	55.6 ± 0.1	57.2 ± 0.1	60.7 ± 0.4	52.36 ± 0.08

The colour and pH parameters are shown in Table 10.

Table 10. Colour parameters and pH of the pulp of 17 different pumpkin genotypes from Greece (%; water pH: 6.9 ± 0.1).

Variety	pH	*L**	*a**	*b**	Color (RGB)
18	5.50 ± 0.03	79.6 ± 0.3	3.1 ± 0.1	42.0 ± 0.6	
19	5.76 ± 0.02	79.3 ± 0.4	5.25 ± 0.06	43.2 ± 0.2	
20	5.23 ± 0.01	77.8 ± 0.1	3.86 ± 0.08	33.39 ± 0.08	
21	5.48 ± 0.06	80.9 ± 0.8	0.6 ± 0.2	34.3 ± 0.6	
22	5.73 ± 0.01	78.4 ± 0.2	5.6 ± 0.2	45.4 ± 0.3	
23	5.873 ± 0.006	83 ± 2	0.7 ± 0.4	34.4 ± 0.2	
24	5.483 ± 0.006	75.0 ± 0.6	1.6 ± 0.3	34.1 ± 0.6	
25	5.40 ± 0.02	76 ± 1	2.9 ± 0.1	37.4 ± 0.5	
26	5.88 ± 0.03	78.5 ± 0.8	1.5 ± 0.2	33.9 ± 0.8	
27	5.37 ± 0.02	79.0 ± 0.3	1.2 ± 0.2	42.2 ± 0.6	
28	5.473 ± 0.006	71 ± 2	5.3 ± 0.4	36.7 ± 0.4	
29	5.39 ± 0.01	70.9 ± 0.4	4.38 ± 0.03	38.0 ± 0.2	
30	5.47 ± 0.03	72.4 ± 0.5	4.60 ± 0.06	36.2 ± 0.4	
31	5.467 ± 0.006	73 ± 2	5.6 ± 0.8	43.6 ± 0.7	
32	4.86 ± 0.02	50.3 ± 0.3	13.4 ± 0.2	37.9 ± 0.6	
33	5.33 ± 0.01	67.9 ± 0.2	7.19 ± 0.04	37.34 ± 0.06	
34	5.88 ± 0.03	81.5 ± 0.6	0.2 ± 0.2	44.0 ± 0.4	

3.2 Samples from Egypt

Table 11 presents the results of fat, protein, ash, energy, carbohydrates, and fiber content of the pulp samples from Egypt. All pulp samples revealed carbohydrates as the major macronutrients, with contents of about 50-61%, followed by protein (about 13-19%), and fat (in average 1.5%). The ash content ranged from about 8 to 11% and the fibers from about 15 to 19%.

Table 11. Proximate composition of the pulp of 5 different pumpkin varieties from Egypt (% dw).

Variety	Fat	Protein	Ash	Carbohydrate	Fibers	Energy
Golden Cushaw	1.27 ± 0.04	14.3 ± 0.4	8.29 ± 0.02	61.0 ± 0.9	15.2 ± 0.4	342.8 ± 0.8
Dickinson	1.53 ± 0.07	13.8 ± 0.4	11.259 ± 0.009	54.6 ± 0.6	18.8 ± 0.2	325.0 ± 0.8
Butternut squash	1.81 ± 0.01	12.9 ± 0.1	10.15 ± 0.06	57.1 ± 0.2	18.0 ± 0.2	332.54 ± 0.01
Halloween	1.50 ± 0.07	19.3 ± 0.3	8.9 ± 0.4	50.8 ± 0.8	19.4 ± 0.2	333 ± 2
Honey Delite	1.59 ± 0.08	14.4 ± 0.2	8.35 ± 0.03	56.60 ± 0.05	19.1 ± 0.2	336.4 ± 0.1

The fatty acids and free sugar contents are shown in Table 12 and 13, respectively. Regarding free sugars, fructose was predominant in all samples, except for the Golden Cushaw, which presented high levels of sucrose. Glucose was also present in high levels in most of the samples. Considerable contents of trehalose and raffinose were also found. Regarding fatty acid profile, the pulp reveled to be rich in saturated and polyunsaturated fatty acids, each one representing about 40-50% of the total.

Table 12. Free sugar content of the pulp of 5 different pumpkin varieties from Egypt (g/100g dw).

Variety	Fructose	Glucose	Sucrose	Trehalose	Raffinose	Total
Golden Cushaw	9.8 ± 0.3	7.4 ± 0.3	13.6 ± 0.5	0.255 ± 0.003	1.90 ± 0.04	33 ± 1
Dickinson	10.9 ± 0.2	4.8 ± 0.1	8.0 ± 0.1	0.132 ± 0.001	1.62 ± 0.02	25.4 ± 0.4
Butternut squash	14.2 ± 0.8	11.9 ± 0.2	2.3 ± 0.2	0.120 ± 0.001	1.61 ± 0.01	30.0 ± 0.8
Halloween	12.1 ± 0.1	8.4 ± 0.2	7.09 ± 0.07	0.40 ± 0.02	1.73 ± 0.02	29.8 ± 0.4
Honey Delite	15.5 ± 0.6	14.0 ± 0.7	1.49 ± 0.07	0.162 ± 0.007	1.59 ± 0.06	33 ± 1

Table 13. Fatty acids content of the pulp of 5 different pumpkin varieties from Egypt (% dw).

Compound	Golden Cushaw	Dickinson	Butternut squash	Halloween	Honey Delite
C10:0	0.0935 ± 0.0007	0.3415 ± 0.0007	0.0710 ± 0.0000	0.143 ± 0.003	0.0805 ± 0.0007
C11:0	-	-	-	0.0675 ± 0.0007	0.0580 ± 0.0000
C12:0	1.61 ± 0.05	2.41 ± 0.01	0.688 ± 0.003	1.39 ± 0.06	1.12 ± 0.05
C13:0	0.252 ± 0.004	0.2035 ± 0.0007	0.241 ± 0.001	0.356 ± 0.006	0.250 ± 0.004
C14:0	1.26 ± 0.02	2.1065 ± 0.0007	0.465 ± 0.002	0.62 ± 0.01	0.48 ± 0.02
C15:0	-	0.564 ± 0.001	0.197 ± 0.001	0.401 ± 0.008	0.1325 ± 0.0007
C15:1	-	-	0.1100 ± 0.0000	-	-
C16:0	30.1 ± 0.3	28.5 ± 0.2	28.3 ± 0.2	30.1 ± 0.4	28.75 ± 0.09
C16:1	-	2.02 ± 0.01	-	-	-
C17:0	0.585 ± 0.007	0.883 ± 0.002	0.68 ± 0.02	0.82 ± 0.01	0.779 ± 0.004
C17:1	-	0.549 ± 0.001	-	-	0.824 ± 0.004
C18:0	11.6 ± 0.1	11.5 ± 0.3	11.4 ± 0.4	13.18 ± 0.07	13.1 ± 0.1
C18:1n9c	5.8 ± 0.2	7.9 ± 0.1	13.2 ± 0.2	6.7 ± 0.2	8.1 ± 0.3
C18:2n6c	25.4 ± 0.3	22.2 ± 0.2	23.6 ± 0.2	25.2 ± 0.2	26.4 ± 0.1
C18:3n3	20.2 ± 0.8	15.81 ± 0.08	16.9 ± 0.2	14.6 ± 0.4	14.20 ± 0.09
C20:0	0.424 ± 0.005	0.83 ± 0.02	0.720 ± 0.004	1.00 ± 0.02	0.93 ± 0.02
C21:0	-	-	-	-	0.836 ± 0.004
C22:0	1.38 ± 0.03	2.51 ± 0.04	1.94 ± 0.05	2.9 ± 0.1	1.495 ± 0.008
C23:0	0.76 ± 0.01	-	-	-	-
C24:0	0.496 ± 0.006	0.848 ± 0.002	0.840 ± 0.004	1.33 ± 0.05	1.386 ± 0.007
C24:1	-	0.775 ± 0.001	0.644 ± 0.004	1.23 ± 0.04	1.082 ± 0.006
SFA	48.6 ± 0.3	50.67 ± 0.06	45.6 ± 0.2	52.2 ± 0.3	49.4 ± 0.3
MUFA	5.8 ± 0.2	11.3 ± 0.1	13.9 ± 0.2	7.9 ± 0.2	10.0 ± 0.3
PUFA	45.6 ± 0.6	38.05 ± 0.08	40.52 ± 0.03	39.8 ± 0.5	40.60 ± 0.03

The chromatic analysis on colour spaces was used (CIELAB colour space) measuring the L* (lightness), a* (redness), and b* (yellowness) parameters to obtain the hue palette and Chroma values of the different pumpkin genotypes. For the pH evaluation, 0.1 g of crushed samples was diluted in 20 mL of distilled water. The results are shown in Table 14.

Table 14. Colour parameters and pH of the pulp of 3 different pumpkin genotypes from Egypt (%; water pH: 4.40 ± 0.04).

Variety	pH	*L**	*a**	*b**	Color (RGB)
Golden Cushaw	6.30 ± 0.04	79.3 ± 0.7	8.7 ± 0.6	53 ± 1	
Dickinson	6.225 ± 0.009	77.7 ± 0.3	6.2 ± 0.2	53 ± 1	
Butternut squash	6.278 ± 0.095	79.13 ± 0.05	1.33 ± 0.03	47.67 ± 0.08	
Halloween	6.040 ± 0.007	78.94 ± 0.03	8.45 ± 0.08	52.56 ± 0.03	
Honey Delite	6.13 ± 0.06	82.27 ± 0.05	5.12 ± 0.09	51.50 ± 0.03	

3.3 Samples from Tunisia

The Tunisian genotype under evaluation is Batati. Table 15 provides an overview of the fat, protein, ash, energy, and carbohydrate contents. Carbohydrates emerged as the primary macronutrient, constituting 68.4% of the total, followed by protein at 14.9%, and fat at 1.49%. The ash content was found to be 15.25%, contributing to an energy intake of 346.5%.

Table 15. Proximate composition of the pulp genotype from Tunisia (%).

Variety	Fat	Protein	Ash	Carbohydrates	Energy
Batati	1.49 ± 0.07	14.9 ± 0.2	15.25 ± 0.09	68.4 ± 0.1	346.5 ± 0.7

The data for free sugars and fatty acids are presented in Tables 16 and 17, respectively. Regarding free sugars, the results indicate the samples is rich in glucose, followed by fructose and sucrose, with a total content of 14.1 ± 0.6 g/100g dw of free sugars.

Table 16. Free sugar content of the pulp from Tunisia (g/100g dw).

Variety	Fructose	Glucose	Sucrose	Trehalose	Raffinose	Total
Batati	4.4 ± 0.2	5.5 ± 0.3	3.8 ± 0.1	0.0 ± 0.0	0.51 ± 0.03	14.1 ± 0.6

As for fatty acids, polyunsaturated fatty acids were the predominant with a total of 53.96 ± 0.02 % (Table 17).

Table 17. Fatty acids of the Tunisian pulp (%)

Compound	Batati pulp
C14:0	1.00 ± 0.04
C16:0	25.9 ± 0.2
C18:0	4.24 ± 0.02
C18:1n9c	13.8 ± 0.3
C18:2n6c	22.9 ± 1.3
C18:3n3	31.0 ± 1.2
C20:0	1.03 ± 0.01
SFA	32.2 ± 0.3
MUFA	13.8 ± 0.3
PUFA	53.96 ± 0.02

The colour and pH parameters are shown in Table 18.

Table 18. Colour parameters and pH of the pulp from Tunisia (%; water pH: 4.92 ± 0.03).

Variety	pH	*L**	*a**	*b**	Color (RGB)
Batati	5.92 ± 0.01	72 ± 2	5.4 ± 0.4	36.7 ± 0.2	

3.4 Samples from Greece, biological cultivation

Also, were evaluated four different genotypes of biological cultivation from Greece. Table 19 provides the proximate composition of this samples. As supposed, carbohydrates were the major compounds in all samples, ranging from about 72 to 81%, followed by proteins and ashes, with low contents of fat (from 1.25 to 4.8%).

Table 19. Proximate composition of the pulp of 4 different pumpkin varieties from Greece (% dw).

Variety	Fat	Protein	Ash	Carbohydrate	Energy
F Bio 1	2.3 ± 0.1	6.2 ± 0.2	10.33 ± 0.07	81.1 ± 0.4	370.3 ± 0.2
F Bio 2-1	4.8 ± 0.2	13.3 ± 0.4	9.8 ± 0.2	72.2 ± 0.8	384.8 ± 0.5
F Bio 2-2	1.25 ± 0.05	6.0 ± 0.3	13.80 ± 0.06	78.9 ± 0.3	351.0 ± 0.5
F Bio 3	1.50 ± 0.04	7.5 ± 0.4	14.9 ± 0.2	76.1 ± 0.2	348 ± 1

The fatty acids and free sugar contents are shown in Table 20 and 21, respectively. Regarding free sugars, the samples presented an amount from 32 to 48 g/100g dw of total free sugars. Except for “F Bio 2-1”, which was rich in sucrose, the other 3 samples were rich in fructose and glucose.

Table 20. Free sugar content of the pulp of 4 different pumpkin varieties from Greece (g/100g dw).

Variety	Fructose	Glucose	Sucrose	Trehalose	Raffinose	Total
F Bio 1	18.1 ± 0.2	18.4 ± 0.9	6.64 ± 0.02	1.35 ± 0.07	0	44.4 ± 0.7
F Bio 2-1	9.4 ± 0.3	7.6 ± 0.3	29 ± 1	1.47 ± 0.07	0	48 ± 2
F Bio 2-2	18.0 ± 0.8	15.8 ± 0.7	9.4 ± 0.4	1.61 ± 0.07	0	45 ± 2
F Bio 3	15.3 ± 0.6	12.9 ± 0.6	3.19 ± 0.09	0.80 ± 0.03	0	32 ± 1

In relation to the fatty acid profile presented in Table 21, the samples presented the same profile of total fatty acids: rich in polyunsaturated fatty acids (more than 50%) followed by saturated fatty acids and with lower levels of monounsaturated fatty acids. Despite that, sample "F Bio 2-2" showed a more diverse profile, with 12 fatty acids identified.

Table 21. Fatty acids content of the pulp of 4 different pumpkin varieties from Greece (% dw).

Compound	F Bio 1	F Bio 2-1	F Bio 2-2	F Bio 3
C14:0	-	-	0.87 ± 0.03	-
C15:0	-	-	0.60 ± 0.04	-
C16:0	18 ± 0.2	11.4 ± 0.1	29.0 ± 0.2	32.4 ± 0.6
C17:0	-	-	0.52 ± 0.03	-
C18:0	3.8 ± 0.1	3.75 ± 0.03	4.0 ± 0.2	-
C18:1n9c	12.2 ± 0.2	14.9 ± 0.1	8.9 ± 0.3	-
C18:2n6c	47.6 ± 0.1	55.2 ± 0.1	29.1 ± 0.2	26.6 ± 1.5
C18:3n3	18.4 ± 0.1	14.76 ± 0.04	22.1 ± 0.1	26.3 ± 0.2
C20:0	-	-	1.17 ± 0.01	-
C22:0	-	-	0.92 ± 0.06	-
C23:0	-	-	1.66 ± 0.07	-
C24:0	-	-	1.24 ± 0.04	6.0 ± 0.4
SFA	21.8 ± 0.1	15.1 ± 0.2	39.98 ± 0.04	41.8 ± 1.0
MUFA	12.2 ± 0.2	14.9 ± 0	8.9 ± 0.3	5.3 ± 0.2
PUFA	65.95 ± 0.04	70 ± 0.2	51.2 ± 0.3	52.9 ± 1.2

The chromatic analysis on colour spaces and the pH evaluation are available in Table 22.

Table 22. Colour parameters and pH of the pulp of 4 different pumpkin varieties from Greece (%; water pH: 4.92 ± 0.03).

Variety	pH	*L**	*a**	*b**	Color (RGB)
F Bio 1	5.63 ± 0.07	82 ± 1	4.90 ± 0.7	46.0 ± 0.6	
F Bio 2-1	5.46 ± 0.03	86.5 ± 0.2	0.46 ± 0.07	24.0 ± 0.4	
F Bio 2-2	5.546 ± 0.008	82.0 ± 0.2	5.8 ± 0.3	42.2 ± 0.5	
F Bio 3	5.60 ± 0.01	87 ± 2	-1.5 ± 0.1	27.29 ± 0.7	