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STUDY ON QUALITY AND SAFETY OF WHITE TOPINAMBOUR *(Helianthus tuberosus), DRY,* AS SOURCE OF RAW MATERIAL FOR FUNCTIONAL FOOD AND PHARMACEUTICAL PRODUCTS

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ABSTRACT

Within this paper, a study on physical and chemical features of white topinambour tuber (Helianthus tuberosus) cultivated in Southern Romania, Fetesti, Ialomita, was performed. For this study, the tuber vegetal product, in dry state, was used, being studied samples taken from the vegetal crop established near the road traffic, starting from the half part of cultivated area and from the farthest side, in order to identify the possible pollutants acting on minerals, oligoelements, but especially heavy metals contained by it; therefore, complementary studies to quality ones have been made in order to determine also the safety aspects of this potential source of raw active matter of natural vegetal origin for food industry, functional food, food supplements and pharmaceutical industry.

INTRODUCERE

Topinambour is a perennial plant having a grassy stalk that can reach 3 m height, the vegetative part of the plant drying in fall. It rises again from underground tubers in spring. The plant has elongate hairy leaves, yellow flowers reaching a diameter of 8-10 cm. Blossom time depends on the region climate; in Central Europe it blossoms in August.

Helianthus tuberosus or topinambour is a medicinal plant and a tasty food. Topinambour tubers have a sweetish taste because they contain inulin, a group of oligosaccharides containing fructose. They can be used in salads, boiled in salty water, fried as French fries or as juice obtained from tubers. It has started to be used more and more as food for diabetics as it contains a polysaccharide well tolerated by patients with high level of blood sugar. It can also be used to obtain certain alcoholic beverages.

Topinambour tubers contain a quantity of up to 20% dry substance with a high content of fructose polymer called inulin, being the biggest inulin deposit in nature. Inulin is a unique natural polysaccharide, with 95% fructose; inulin, by hydrolysis, is transformed into fructose which is about. 1.7 times sweeter than sucrose and 3 times sweeter than glucose.

Besides topinambour, inulin can be found in chicory, dandelion and other plants roots, but in smaller quantities. Inulin has a beneficial effect from stomach level to gastrointestinal tract, where it is absorbed in blood. It gathers and carries a large amount of substances unnecessary for the organism, thus helping eliminate heavy metals,

radionuclides, cholesterol, fatty acids and various toxic chemicals. Inulin stimulates the ability of contracting intestine walls, which accelerates cleansing the body of toxins and residues.

Topinambour actively accumulates silicon from the soil (in the tubers, the content in this element is up to 8%, expressed in dry matter). It has a higher content of iron, silicon and zinc than potato, carrot and beet. Proteins, pectin, amino acids, organic acids and fatty acids are also in the composition of topinambour tubers. Pectic substances in topinambour are reached in 11% of dry substance mass.

The fibre enhances cleansing process of the organism. Consequently, it has a complex effect on liver functioning and its detoxication.

- Acts as a natural prebiotic undigested part of inulin arrives in the colon unaltered, providing a food source for probiotic bacteria enhances intestine peristalsis acts as a non-digestible fibre in the diet and so can help relieve constipation decreases the energetic value of foodstuffs.
- Diabetics help: decreases blood sugar levels, as the undigested part of inulin as well as the fibre absorb a large amount of glucose from the food consumed. It also slows the absorption of carbohydrates.

Inulin is an excellent food for all who want to avoid diabetes since inulin makes no demand on the pancreas to produce surges of insulin. That is able to accumulate silicon from the soil.

Fig.1 – *Helianthus tuberosus*plant and flower

Fig.2 – *Helianthus tuberosus*tubercle [18]

Unlimited fields, considered as first- class lands, are those with deep well drained and aerated soil, easy to work, presenting a good permeability and water stocking, with relative high natural fertility for most culture plants adapted to climate conditions and which are not difficult to be exploited as arable field. The lands in this category are found mainly in drained areas from the regions covered by loess, having soils from mollisols class.

MATERIALS AND METHODS

In SC Hofigal Export Import SA, in order to obtain the dry vegetal product of topinambour (*Helianthus tuberosus*), the fresh vegetal product, after being harvested, is subject to the following operations:

• *sorting* fresh vegetal product;
• *washing* the vegetal product;
• *drying* the vegetal product;
• *mincing the dry vegetal product*.

Methods of analysis used: all the laboratory analyses were performed according to provisions from European Pharmacopoeia, edition 8.

- For identifying the **MACROSCOPIC** CHARACTERISTICS, a microscopic control of underground organs is performed to establish their type (root, underground stem), as well as the presence or absence of striations, if they are longitudinally or transversally cut, with or without scars, fractures, their size, colour, etc. Dimensions (length, thickness) are determined in the most developed area of underground organ, by means of a graduated ruler.
- For identifying the **FLAVONOIDS**, the following equipment was used*:* water bath and analytical balance, and as *reagents:sodiumacetate R, solution 100 g/L; aluminium chloride R, solution 25 g/L; methanol R; ethanol R, solution 50% (V/V); solution test for liquid samples to be analysed:* at a certain quantity of sample to be analysed, according to Technical Specification, 100 ml of *ethanol R, solution 50% (V/V)* is added in a large-neck flask and is heat to the boiling point, on a water bath, under reflux, for 30 minutes. The hot solution is filtered (if necessary) and is completed at 100 mL by washing the residue, with the same solvent.
- For identifying **INULIN, the** *equipment* used was*:* spectrophotometer UV-VIS and as *reagents:* resorcinol solution R 0.09 M in ethanol R (freshly prepared): 9.9g resorcinol R is dissolved in 1000 mL ethanol R; perchloric acid solution R 50 g/L: 42,7 mL perchloric acid R is diluted in 1000mL water R; hydrochloric acid R; ethanol R; water R; test solution for solid products (powders, plants, tablets, capsules): 0.5g sample to be analysed are triturated with 50.0 mL water R at ambient temperature. It is let for 10 minutes, agitating from time to time. Afterwards it is filtered.
- For identifying **POLYPHENOLS,** the *equipment* used was*:*analytical balance; reagents*: fosfowolframic sodiumsolution R (Folin reagent):* 10g *fosfowolframic sodium* R, 10 mL *phosphorus acid R and* 75 mL *water R* are heated to boiling temperature, under reflux for 2 hours. After having cooled, it is completed with water *R* at 100 mL; *sodium carbonate R solution 200 g/L*; *ethanol R solution 50 % v/v; test solution*: at a certain quantity of sample to be analysed provided in product Technical Specification, 100 mL *ethanol R solution 50 % v/v* are added in a large-neck flask and is brought to boiling point on water bath, under reflux, for 30 minutes. The hot solution is filtered, if necessary.
- For identifying **SUGARS**,the *reagents* used were*:* reagent Feling I: 34.66g copper sulphate R is dissolved in 200 mL water R and completed up to 500 mL with the same solvent; reagent Feling II: are dissolved 173 g potassium and sodium tartrate R and 50 g sodium hydroxide R in 200 mL water R without carbon dioxide and is completed up to 500 mL with the same solvent. Before use, equal volumes of the 2 solutions are mixed; water R, without carbon dioxide: water R is boiled for a few minutes and the vessel is covered for avoiding the contact with atmosphere; test solution: for 1.0 g sample to be analysed 100 mL ethanol R solution 50% (V/V) are added in a large-neck flask and is brought to boiling point on water bath, under reflux, for 30 minutes. The hot solution is filtered, if necessary.

- For **LOSSES BY DRYING** the*equipment* used was*:* oven, analytical balance, and as *reagents:* sand R;
- For **TOTAL ASHES,** the *equipment* used was*:* calcination oven and as *reagents:* hot water R.
- For determining the **CONTENT OF TOTAL POLYPHENOLS EXPRESSED IN CHLOROGENIC ACID / CAFFEICACID**, the *equipment* used was*:* analytical balance and spectrophotometer UV-VIS and as *reagents:* sodium wolframate R; phosphoric acid R; water R; fosfowolframic sodium solution R (Reagent Folin: 10 g wolframic sodium R, 10 mL phosphoric acid R and 75 mL water R are heated up to boiling temperature, under reflux, for 2 hours; after cooling, it is diluted with water R at 100 mL; sodium carbonate solution R 200 g/L; caffeic acid R; standard solutions: solution of caffeic acid R 20 µg/mL, solution of caffeic acid R 30 µg/mL, solution of caffeic acid R 40 µg/mL, solution of caffeic acid R 50 µg/mL, solution of caffeic acid R 60 µg/mL, solution of caffeic acid R 70 µg/mL, solution of caffeic acid R 80 µg/mL, solution of caffeic acid R 90 µg/mL, ethanol R solution 50% v/v, test solution: for 1.0g *sample to be analysed* are added 100mL *solution of ethanol 50% v/v R*, in a flask with ground-glass stopper and is heated up to boiling temperature, on water bath, under reflux, for 30 minutes. The hot solution is filtered through absorbent cotton in a flask of 100mL and after cooling the solution is completed up to 100mL by washing the residues with *ethanol solution 50% v/v R.*
- For determining the **INULIN CONTENT the***equipment* used was: a spectrophotometer UV-VIS and as *reagents:* resorcinol R, solution 0.09 M in ethanol R (freshly prepared); hydrochloric acid perchloric acid R; inulin R; perchloric acid R, solution, 5 %; test solution: 0.2 sample to be analysed is tritrated with 50.0 mL water R at ambient temperature. It is let to rest for 10 minutes, agitating now and then. It is filtered and diluted at 100.0 mL with water R; stock solution of inulin: 50 mg inulin R are weighed, diluted into water R and brought at 100.0 mL level with the same solvent; reference solution: 0.2 mL test solution, 1.2 mL water R, 1,6 mL perchloric acid R, solution 5 % and 3.0 mL hydrochloric acid R.
- For determining the **CONTENT OF TOTAL SUGAR**,the following*equipment* was used:spectrophotometer UV-VIS and as r*eagents:* solution 1: potassium ferrocyanide ,K3[Fe (CN)6], solution 0.5 N: are dissolved 16.5 g potassium ferrocyanide R at 1 L of water R; solution 2: sodium carbonate, (Na2CO3), solution 1.0 N: 106 g sodium carbonate R are dissolved at 2 L water R; sulphuric acid R, solution 0.8 N; ethanol R, solution 50% (v/v); saturated solution of lead acetate, glucose R; active carbon; reference solution: 2.0 mL water R and 5.0 mL solution 2; solution 3: 2 mL solution 1 are diluted at 100 mL with solution 2. When it is used, the test solution is prepared: In an Erlenmayer glass, a sample of 0.2g is weighed, 50mL ethanol R 50% (v/v) are added and it is agitated for 10 minutes. 2-3 drops of saturated solution, lead acetate and a spatula tip with active carbon are added. The sample to be analysed is filtered in a quoted flask and diluted at 100mL with water R.
- For determining the **CONTENT OF REDUCING SUGARS** the *equipment* was used: spectrophotometer UV-VIS and as *reagents:* solution 1: potassium ferrocyanide, K3[Fe (CN)6], solution 0.5 N:16.5 g potassium ferrocyanideR are dissolved in1000 mL water R; solution 2: sodium carbonate, (Na2CO3), solution 1.0 N: 106 g sodium carbonate R are dissolved in2000 mL water R; sulphuric acid R, solution 0.8 N: 21.4 mL sulphuric acid R are dissolved in1000 mL water R; ethanol R, solution 50% (v/v); saturated solution of lead acetate; glucose R; water R; active carbon R; reference solution: 2.0 mL water R and 5,0 mL solution 2. The mixture obtained is heated in water bath for 25 minutes at 80°C; solution 3:2 mL solution 1 is diluted at 100 mL with solution 2; solution test: In an Erlenmayer glass, a sample of 0.2g is weighed, 50mL ethanol R 50% (v/v) are added and agitated for 10 minutes. 2-3 drops of saturated solution, lead acetate

and a spatula tip with active carbon are added. The sample to be analysed is filtered in a quoted flask and diluted at100mL with water R.

- For determining the **CONTENT OF REDUCING SUGARS** the*equipment* used was*:* spectrophotometer UV-VIS and as *reagents:* solution 1: potassium ferrocyanide ,K3[Fe (CN)6], solution 0.5 N:16.5 g potassium ferrocyanideR are dissolved in1000 mL water R; solution 2: sodium carbonate, (Na2CO3), solution 1.0 N: 106 g sodium carbonate R are dissolved in 2000 mL water R; sulphuric acid R, solution 0.8 N: 21.4 mL sulphuric acid R are dissolved in1000 mL water R; ethanol R, solution 50% (v/v); saturated solution of lead acetate; glucose R; water R; active carbon R; reference solution: 2.0 mL water R and 5,0 mL solution 2. The mixture obtained is heated on water bath for 25 minutes at 80°C; solution 3:2 mL solution 1 is diluted at 100 mL with solution 2; test solution: In an Erlenmayer glass, a sample of 0.2g is weighed, 50mL ethanol R 50% (v/v) are added and agitated for 10 minutes. 2-3 drops of saturated solution, lead acetate and a spatula tip with active carbon are added. The sample to be analysed is filtered in a quoted flask and diluted at 100mL with water R.
- For determining the **CONTENT OF MINERALS** the *equipment* used was:analytical balance, atomic absorption spectrometer equipped with: cathode-ray lamps as source of radiations, deuterium lamp used as a background correcting device, PC and printer. *Working conditions:* wave length at which the determination is made for different metals is shown in table 1:

Table 1. Wave length at which the determination for different metals is made

Metal	Cadmium (Cd)	Copper (Cu)	Iron (Fe)	Calcium (Ca)	Lead (Pb)	Zinc (Zn)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Manganese (Mn)	Selenium (Se)	Nickel (Ni)	Silicon (Si)	Chrome (Cr)
Wave length (nm)	228.8	324.8	248.3	422.7	217.0	213.9	202.6	589.6	766.5	279.5	196.0	232.0	251.6	357.9

Reagents: hydrochloric acid R, without heavy metals; nitric acid R, without heavy metals; hydrofluoric acid R, without heavy metals; standard solution of respective metals of 1000 ppm; reference solutions: for obtaining the calibration curve, reference solutions of different concentrations are used, being prepared from the standard solution of 1000 ppm, in nitric acid solution 1%, according to table 2:

Table 2. Metal reference solutions

Name	**Metal reference solutions** (µg/mL, ppm)						
Cadmium (Cd)	0.2	0.4	0.6	1.0	-	-	-
Copper (Cu)	1.0	2.0	3.0	4.0	5.0	-	-
Iron (Fe)	1.0	2.0.	3.0	4.0	5.0	-	-
Calcium (Ca)	1.0	2.0.	3.0	4.0	-	-	-
Lead (Pb)	0.2	0.5	1.0.	1.5	-	-	-
Zinc (Zn)	0.1	0.3	0.5	1.0	1.5	-	-
Sodium (Na)	0.2	0.4	0.6	0.8	1.0	1.2	-
Potassium (K)	0.4	0.6	0.8	1.0	1.2	-	-
Magnesium (Mg)	1.0	5.0	10.0	15.0	20.0	-	-
Manganese (Mn)	0.1	0.2	0.4	0.6	1.0	1.5	2.0
Selenium (Se)	0.5	1.0	2.0	3.0	4.0	5.0	-
Nickel (Ni)	1.0	2.0	4.0	6.0	8.0	-	-
Silicon (Si)	10.0	50.0	100.0	150.0	200.0	-	-
Chrome (Cr)	0.5	1.0	2.0	3.0	5.0	-	-

RESULTSAND DISCUSSIONS

1. Evolution of Helianthus tuberosus culture and obtaining the vegetal product as tuber

Starting with the plant sowing the evolution of culture was monitored in its different moments of growing (fig. 3).

Fig.3 – *Helianthus tuberosus*

2. Analysis of dry vegetal product under controlled conditions minced using grinding mill for vegetal material MMC 2

No.	Characteristics	Results FET - A dry
1	Macroscopic features	Topinambour tubers resulted from heel end, by thickening the underground and final part of the stem, are of black-greyish colour. They are of different size up to 8-9 cm as diameter. They have different shapes, oval or oblong, being single or grouped by 2-3 at the same place. In crossing section, at the external part we may notice a grey layer made of epidermal cells and the inner content made of additional tissues of white colour.
2	Identification: -flavonoids(chemical reaction) -inulin (chemical reaction) -polyphenols(chemical reaction) -sugars (chemical reaction)	 No chemical reaction Is appropriate Is appropriate Is appropriate
3	Drying loss,%, max	4.2
4	Total ash,%, max	4.0
5	Content of total polyphenols expressed in: - caffeic acid,% - chlorogenic acid, %	 0.2 0.4
	- inulin, %	19.26
	- total sugar, %	42.7
	- reducing sugar, %	37.4
	- minerals: Ca Mg Na K Mn Fe Zn Cu Pb Cd Cr	 61 137 52 615 <0.1 <0.2 1.2 ND ND ND ND

3.Analysis of samples of dry vegetal product and taken from three points in culture working depth

3.1. Analysis of samples of dry vegetal product taken from inner part

No.	Characteristics	Results White topinambour tubers ***inner***
1	Macroscopic features	Topinambour tubers resulted from heel end, by thickening the underground and final part of the stem, are of black-greyish colour. They are of different size up to 8-9 cm as diameter. They have different shapes, oval or oblong, being single or grouped by 2-3 at the same place. In crossing section, at the external part we may notice a grey layer made of epidermal cells and the inner content made of additional tissues of white colour.
2	Identification: -flavonoids(chemical reaction) -inulin (chemical reaction) - polyphenols (chemical reaction) -sugars (chemical reaction)	 No chemical reaction Is appropriate Is appropriate Is appropriate
3	Drying loss,%, max	8.87
4	Total ash,%, max	3.42
5	Content of total polyphenols expressed in: - caffeic acid,% - chlorogenic acid, %	 0.11 0.22
	- inulin, %	27.85
	- total sugar, %	85.94
	- reducing sugar, %	43.48
	- minerals: Ca Mg Na K Mn Fe Zn Cu Pb Cd Cr	 14.0 25 35 650 ND ND 2.3 ND ND ND ND

3.2. Analysis of samples of dry vegetal product taken from middle part

No.	Characteristics	Results White topinambour tubers ***middle***
1	Macroscopic features	Topinambour tubers resulted from heel end, by thickening the underground and final part of the stem, are of black-greyish colour. They are of different size up to 8-9 cm as diameter. They have different shapes, oval or oblong, being single or grouped by 2-3 at the same place. In crossing section, at the external part we may notice a grey layer made of epidermal cells and the inner content made of additional tissues of white colour.
2	Identification: -flavonoids(chemical reaction) -inulin (chemical reaction) -polyphenols(chemical reaction) -sugars (chemical reaction)	 No chemical reaction Is appropriate Is appropriate Is appropriate
3	Drying loss,%, max	8.93
4	Total ash,%, max	2.93

5	Content of total polyphenols expressed in: - caffeic acid,% - chlorogenic acid, %	 0.09 0.18
	- inulin, %	31.86
	- total sugar, %	88.63
	- reducing sugar, %	46.86
	- minerals: Ca Mg Na K Mn Fe Zn Cu Pb Cd Cr	 16.0 28 40 700 ND ND 2.5 ND ND ND ND

3.3. Analysis of samples of dry vegetal product taken from exterior part

No.	Characteristics	Results White topinambour tubers *exterior*
1	Macroscopic features	Topinambour tubers resulted from heel end, by thickening the underground and final part of the stem, are of black-greyish colour. They are of different size up to 8-9 cm as diameter. They have different shapes, oval or oblong, being single or grouped by 2-3 at the same place. In crossing section, at the external part we may notice a grey layer made of epidermal cells and the inner content made of additional tissues of white colour.
2	Identification: -flavonoids(chemical reaction) -inulin (chemical reaction) -polyphenols(chemical reaction) -sugars (chemical reaction)	 No chemical reaction Is appropriate Is appropriate Is appropriate
3	Drying loss,%, max	8.37
4	Total ash,%, max	3.89
5	Content of total polyphenols expressed in: - caffeic acid,% - chlorogenic acid, %	 0.08 0.16
	- inulin, %	29.95
	- total sugar, %	82.85
	- reducing sugar, %	47.99
	- minerals: Ca Mg Na K Mn Fe Zn Cu Pb Cd Cr	 14.0 28 35 700 ND ND 2.4 ND ND ND ND

CONCLUSIONS

Analysing the results obtained from the samples of dry vegetal product taken from different points on crop surface, the following may be concluded:

A. Dry product does not generate chemical reaction when identifying with flavonoids, but is appropriate, with positive results by chemical reaction when identifying: inulin, polyphenols and sugar.

B. Drying loss is relatively small 4.2%, total polyphenol content expressed in caffeic acid, % is of 0.2%; total polyphenol content expressed in chlorogenic acid, %, is of 0.4; content of inulin is of 19.26 %; content of total sugar, %, is of 42.7 %; content of reducing sugar, %, is of approximately 37.4 %, a very good ratio between the ions of calcium and magnesium ones being found, in favour of magnesium, as well as between sodium and potassium in potassium favour. Dry plant has a content of mineral salts mentioned above between 3 and 10 times higher compared to the fresh plant, manganese and iron being present below 0.1 respectively 0.2% while zinc is in percentage of 1.2%.

C. Vegetal product dried under controlled conditions is qualitatively superior to the fresh one, much more stable and shows no (total absence of heavy metals) lead and cadmium, which confers not only the product safety but also its quality.

D. Vegetal product topinambour (*Helianthus tuberosus*) cultivated represents an ideal natural source of vegetal origin both for raw material related to food and nutrition and as medicinal plant with beneficial effects also at economic level.

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