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Scientific paper

Evaluation of chemical composition and sensory profile in Jerusalem artichoke (*Helianthus tuberosus* L) tubers: The effect of clones and cooking conditions

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ABSTRACT

Jerusalem artichoke (*Helianthus tuberosus L.*) (JA) produces ground artichokes, is resistant to most parasites, diseases and tough conditions such as frost and drought.

It has many applications including biofuels or bio-chemicals that do not compete with food supply. Improving the genetic diversity would help meet food demand.

Four clones of the JA were studied to determine sensory attributes, facilitate the characterization of each clone and promote a better use and consumption.

The sensory attributes of raw and boiled JA tubers have been identified by a trained panel, in compliance with the UNI EN ISO13299: 2010 standard; the geometric mean (M) has been applied to reduce the number of descriptors in order to produce a sensory assessment sheet for tests. The principal component analysis (PCA) of the average values was applied to the data to evaluate the importance of each selected attribute in the samples identification.

The results clearly showed that the 16 attributes selected for raw and 14 for cooked are useful for discriminating the 4 clones.

Knowledge of the sensory characteristics of different clones of raw and cooked tubers of Jerusalem artichoke can be used to inform consumers about the right choice of Jerusalem artichoke tubers for their needs and therefore increase consumption of this vegetal, which has many beneficial effects on human health.

Introduction

Jerusalem artichoke (*Helianthus tuberosus L.*) is a species of the Asteraceae family, genus Helianthus, known for the remarkable genetic variability of its clones and genotypes (Puttha et al., 2013; Rossini et al., 2012). It consists of 66 species native to the United States and south east of eastern and central Canada: it is an old species, originally grown mainly in North America and later in Europe where it can grow in nature (Balogh, 2008; Slimestad et al., 2010).

The taxonomic classification of the topinambur is uncertain and widely discussed (Filep et al., 2010); however, the numerous varieties of Helianthus tuberosus L. were classified by Cockerell (1919) as follows: var. *typicus*; var. *nebrascensis;* var. *alexandri*; var. *purpurellus*; var. *fusiformis*; var. *albus;* var. *purpureus*; var. *multituberculatus*.

In Mediterranean regions it spontaneously grows virtually everywhere and does not require any kind of fertilizer or organic matter and should not be subjected to pesticides. Its rapid and vigorous growth allows good natural control against weeds, which hardly exceed the plant (Rosati, 2010).

In fact, JA is mainly cultivated for use as green or brackish fodder as crops in marginal areas, in particular in relation to hardiness and low production costs (Shanzhao et al., 2013) and for the production of sugars (in particular fructose) and soluble fiber (inulin). The plant is also an excellent resource for bioenergy production, such as bioethanol, methane, anaerobic digestion and biogas from pyrolysis (Kim and Kim, 2014).

JA can be appreciated not only as a biomass crop resource but also for its nutritional and medical qualities as an accessible source of protein and essential amino acids (Cieślik et al., 2011), minerals (Somda et al., 1999; Takeuchi and Nagashima, 2011; Terzić et al., 2012) and a number of functional ingredients such as inulin, oligofructose and fructose.

In addition, it has both nutritional and functional attributes, particularly beneficial for individuals with type 2 diabetes and obesity (Saengthongpinit and Sajjaanantakul, 2005; Yang et al., 2015).

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In particular, inulin is the main preservative carbohydrate in JA (10–20% by weight of fresh tubers) and is used for the production of dietary fibers, feed, high carbohydrate fructose syrup, bioethanol or biochemical materials by fermentation of microorganisms (Mee-Jin et al., 2016).

It is a food fiber not degraded by digestive enzymes and has been shown to have a prebiotic effect on humans (Kleessen et al., 2007; Ramnani et al., 2010). Some studies also report that tuber was used in the past in popular medicine for the treatment of diabetes and rheumatism (Kays and Nottingham, 2007).

Jerusalem artichoke (JA), as a source of food, was well-known to American Indians long before the arrival of the white man (Cockerell, 1918).

Recently JA has become very popular especially in France, Italy and Germany. There are several ways that can be consumed: raw, cooked, stewed, soup or salad, cooked or pure.

Tuber is well-known in restaurants in Northern Europe, where it is generally served in raw, boiled, pure or soup salad. However, the use of JA in domestic cooking is limited because the product is poorly available on the market. For this reason, the quality of available clones and their ability to be marketed must be considered more closely.

Greater knowledge of sensory properties, gourmet quality, and suitability for JA tubes are needed to meet consumer demand and increase consumption.

High inulin content in the tubers makes them particularly suitable for creams and purees; in fact, inulin mixed with water creates a soft and creamy gelatin texture (Franck, 2002).

Many researchers have focused on the sensory description of different plant species, aimed at comparing or characterizing products according to several variables, such as geographic origin, cultivation method, system, or conservation time. Sometimes, the sensory profile has been centered exclusively on the aromatic description of the product or its different cultivars, or in the description of the modifications required by the cooking techniques. Some examples of this type of work are Di Salvo et al. (2014) on a DOP artichokes; Arvanitoyannis et al. (2008) about two cultivars of raw and cooked potatoes; Smith et al. (2006), with a pepper study and finally a comparison of 5 varieties of sweet potato (Leighton et al., 2010).

Since very few studies have examined the sensory characteristics of both JA raw and cooked tubers (Bach et al., 2012, 2013a, 2013b), our work seeks to examine the new JA clones use for food purposes.

Developing an appropriate vocabulary allows you to evaluate both the sensory quality of the tubers as well as the identification of some sensory attributes, predictors of the specific suitability of the various JA clones in cooked and raw gourmet preparations.

So, it is hoped that this knowledge will increase demand and will be an attractive source of food in the future.

Materials and methods

Plant material

Four clones of the Jerusalem artichoke (JA) tubers were selected for sensory and chemical analysis. The genotypes were grown in the Experimental Farm (EF) of the University of Tuscia, located in Viterbo, Central Italy (42°42'N, 12°08'E, altitude: 326 masl). Tested in a previous study (Rossini et al., 2012), they have proven to be suitable for the Mediterranean environment.

The clones (Fig. 1), K8, D19-Blanc precoce, CU3B-Hungarian clones, selected from the EF collection (Bizzarri et al., 2011; Gutierrez Pesce et al., 2011) were chosen to include a large variation in sensory characteristics and compared with Violet de Rennes cv, from the same collection, commercially used.

Tubers of 30–45 g size and free from defects were used for the chemical and sensory analysis. After harvesting, the tubers were washed, dried, sealed in polypropylene bags (PP approved by FDA/USDA), and maintained at 4 °C ± 2 and ≥98% relative humidity until analysis (maximum 1 week).

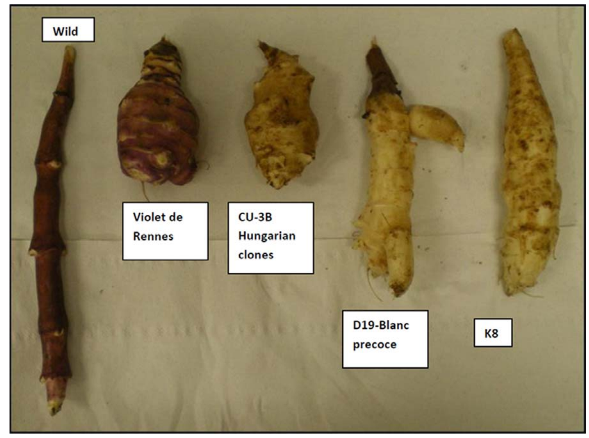

Fig. 1. Tuber shapes of Jerusalem artichoke from *Tuscia University* collection.

Chemical analyses

Chemical analyses of Jerusalem artichoke tubers was determined by standard methods (AOAC, 1999). For moisture content and ash measurement, standard gravimetric method was used. The amount of protein was determined by the Kjeldahl method and calculated as the nitrogen content×6.25 (Takeuchi and Nagashima, 2011). The determination of total sugar was determined using a refractometer (ATAGO PR-32α-Palette series).

All chemical analysis were performed in triplicate for each preparation.

Sample preparation

Before the analysis, the Jerusalem artichoke tubers were hand peeled and diced into 2 cm × 2 cm cubes. For the boiled preparation, 200 g of Jerusalem artichoke cubes were placed in a beaker together with 200 mL of water, and covered with perforated Parafilm.

The different samples were boiled in a microwave oven at 750 W for 5 min, then cooled in iced water, drained and finely chopped to make a puree. Then they were stored at room temperature before the test that was performed about 15 +/− 1 min later.

Sensory analysis

The sensory analysis was performed on any clone of the Jerusalem artichoke tubers, both raw and boiled, by a trained sensory panel composed by twelve judges (eight women and four men) aged between 25 and 55 years.

All the assessors had already eaten topinambur, were familiar with it, and did not object to eating it.

For the development of the lexicon, a well-known (University of Tuscia) expert sensory assessor, trained and monitored according to ISO 8586-1, 2012 was selected.

The profiling of the JA was performed in a sensory evaluation laboratory that conforms with the international standards (ISO 8589, 1988). Before the official test, two preliminary sessions were carried out to allow the assessors to become familiar with the product.

The development of the lexicon for the JA sensory evaluation was completed in three sessions, according to ISO 11035 (1994), with modification in M value reduction.

At the beginning, the panelists evaluated the raw and cooked samples (Test 1), presented in a monadic sequential order, to individually recognize the attributes that best described each sample.

All the descriptors were collected into a list that was then reduced