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# Toward a traceability of European pine nuts "from forest to fork"

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**Abstract.** Mediterranean pine nuts from *Pinus pinea* are among the world's most expensive nut species, considered gourmet and health food, due to their rich flavour and excellent dietetic values (35% proteins, 50% fat, mostly omega-6 and -9). But pine nuts industry is very small and locally concentrated, which implies economies of scale rather than economy of scope mechanisms, and a high vulnerability due to a lack of commercial and marketing structures and dependence on one single product and its supply, the annual pine cone yield as wild crop from forests. Major current challenges of Mediterranean stone pine are thus the implementation (and fulfilment) of high quality standards along the supply chain and, very especially, to achieve legal and commercial differentiation from other edible pine seeds that are still sold indistinctly by the generic name "pine nuts": besides *P. pinea*, especially *P. sibirica*, *P. gerardiana*, and *P. koraiensis*. The last one comes from China and holds about 80% of the world market for pine nuts, though it has been marketed in lots mixed and mingled with seeds from other pine species, some of them non-edible like *P. armandii* that causes the Pine Mouth Syndrome, a long-lasting taste disturbance. Recently in June 2012, a new reviewed trading standard was proposed by the UNECE for pine nut kernels, enforcing the uniformity of commercial packages that should contain only kernels of the same species, with the obligate mention of the botanical species name in the product label.

**Keywords.** Mediterranean pine nuts – *Pinus pinea* – Pine Mouth Syndrome – Food safety – Product labeling – Trade standards.

## Vers une traçabilité des pignons de pins européens "de la forêt à la fourchette"

**Résumé.** Les pignons de pins méditerranéens *Pinus pinea* sont parmi les espèces de fruits secs les plus onéreuses au monde, et sont considérées comme une denrée pour gourmets et un aliment-santé, en raison de leur riche saveur et de leurs excellentes valeurs diététiques (35% de protéines, 50% de matière grasse, principalement omega-6 et -9). Mais l'industrie des pignons est très petite et concentrée localement, ce qui implique des économies d'échelle plutôt que des mécanismes d'économie de gamme, et une forte vulnérabilité due au manque de structures commerciales et de marketing et à la dépendance d'un seul produit et de son approvisionnement, à savoir la production annuelle de cônes de pin comme objet de cueillette dans les forêts. Les défis majeurs pour les pins pignons méditerranéens sont donc la mise en place (et le respect) de normes de qualité plus exigeantes tout le long de la chaîne d'approvisionnement et en particulier l'application d'une différenciation juridique et commerciale par rapport aux autres semences comestibles de pin qui sont encore vendues indifféremment sous le nom générique de "pignons" : en plus de *P. pinea*, figurent notamment *P. sibirica*, *P. gerardiana*, et *P. koraiensis*. Ce dernier provient de Chine et représente environ 80% du marché mondial des pignons, bien que commercialisé en lots mélangés et confondus avec des semences d'autres espèces de pins, dont certaines non comestibles comme *P. armandii* qui est cause de dysgueusie, une altération du goût de longue durée. Dernièrement, en juin 2012, une nouvelle révision de la réglementation commerciale a été proposée par l'UNECE pour les pignons, afin d'uniformiser les lots commerciaux qui ne devraient ainsi contenir que des pignons de la même espèce, et mentionner obligatoirement le nom de l'espèce botanique sur l'étiquette du produit.

**Mots-clés.** Pignons méditerranéens – *Pinus pinea* – Dysgueusie – Sécurité sanitaire des aliments – Étiquetage des produits – Standards commerciaux.

## I – Mediterranean pine nuts, gourmet food from forests

The Mediterranean pine nuts, the edible kernels of stone pine *Pinus pinea* L., are one of the world's top-ten nut species. Pine nuts are currently the most relevant forest product of stone pine forests in the Mediterranean, the forest owner obtaining a higher profit from cone yield than from timber. Moreover, the income is annual and not only in final cuttings at the end of rotation. The mean annual world's pine nut production is estimated in 6.000 t (shelled), virtually all the production still being harvested from the wild. This character as non-timber forest product implies that no specific horticultural techniques are applied and no defined cultivars are used. In the genuine stone pine forests, especially in semiarid Mediterranean climate zones and on poor sandy or rocky sites, the annual mean cone yield ranges from 100 to 1,000 kg/ha, rendering only 4 to 40 kg shelled pine nuts. In more favourable regions like coastal Portugal with a more humid climate, mean production can more than double easily the upper value.

Mediterranean pine nuts are considered gourmet and health food, with a rich flavour and excellent dietetic values (35% proteins, a percentage similar to raw soybeans, and only 50% fat, mostly unsaturated omega-6 and -9 fatty acids). The high prices obtained in the world market, up to 50-60 euros/kg for shelled pine nut as retail price, have motivated the attention of this forest nut by researchers during the last decades. Improvement programmes have been developed aiming to increment the pine nut production and ultimately profitability of forest lands. Clonal selection of plus trees with high cone yield in forests and their evaluation in grafted trials, has allowed for selection of the best-performing clones in each agro-climatic zone, the legal release of superior clones being imminent in Spain for their use in agroforestry systems or grafted orchards (Mutke *et al.*, 2012).

## II – Pine species with edible seeds

The pine nuts' character as historically minor forest product implied until few decades ago an insufficient structure of pine cone processing sector, frequently locally concentrated in few villages with a specialised pine nut processing industry, such as in Pedrajas de San Esteban in Spain, Alcácer do Sal in Portugal or Kozak in Turkey, which produce each more than the half of the respective total national pine nut supply. This local concentration implies economies of scale rather than economy of scope mechanisms, and a high vulnerability due to a lack of commercial and marketing structures and dependence on one single product and its supply, the annual pine cone yield, a wild crop collected from forests. Major current challenges of Mediterranean stone pine on international market are thus the implementation (and fulfilment) of high quality standards along the supply chain and, very especially, to achieve legal and commercial differentiation from other edible pine seeds that are sold indistinctly by the generic name "pine nuts". Actually more than 20 different pine species in the world produce edible kernels, besides the Mediterranean pine nut (*P. pinea*) especially the Swiss or Arolla pine (*P. cembra*), its near related red cedar or Siberian pine (*P. sibirica*), whose oil is relevant in the domestic Russian market, the Chinese pine (*P. koraiensis*) that holds about 80% of the world pine nut market, though sometimes mixed and mingled with seeds from other pine species (some of them even nonedible), the Chilgoza or Pakistani pine (*P. gerardiana*), and the American pinyon pines (several species such as *P. cembroides*, *edulis*, *monophylla* and others) (FAO, 1998) (Fig. 1). Virtually all of them are still wild crops, or gathered from rural groves, not from horticultural plantations or orchards, and the limited supply of all of them does not satisfy the increasing demand (Mutke *et al.*, 2012).

On the other hand, the different pine nut species have very different tastes, dietary values (Table 1), and processing quality, thus they are, and must be recognised as, different products that should be differentiated in the market for consumers' security. *E.g.*, true Mediterranean pine nuts double the protein contents of the two other main commercial species, Chinese and Pakistani pine nuts.



**Fig. 1. Shelled pine nuts. a.- Mediterranean pine (*P. pinea*); b.- Chinese pine (*P. koraiensis*); c.- Chilgoza pine (*P. gerardiana*).**

**Table 1. Mean dietary value of shelled pine nuts**

Species	Proteins	Fats	Carbohydrates
<i>P. pinea</i>	33–38 %	46–51 %	5–6 %
<i>P. cembra</i>	17–18 %	50–59 %	17 %
<i>P. sibirica</i>	17–19 %	51–75 %	12 %
<i>P. koraiensis</i>	14–18 %	65–68 %	5-12 %
<i>P. gerardiana</i>	12–14 %	51–61 %	20–23 %
<i>P. cembroides</i>	19 %	60–65 %	14 %
<i>P. edulis</i>	14 %	61–71 %	18 %
<i>P. monophylla</i>	10 %	23 %	54 %

Sources: Lanner, 1981; López-Mata, 2001; Montero *et al.*, 2004; Evaristo *et al.*, 2012.

### III – The Pine Mouth Syndrome, a serious taste disturbance after consumption of Chinese pine kernels

Pinolenic acid is a specific polyunsaturated fatty acid that is characteristic for *P. sibirica* and *P. koraiensis* seeds, reaching in the latter 12% of total fat contents. On the contrary, Mediterranean pine nuts have a low content of pinolenic acid. This fatty acid stimulates the enteroendocrine system to produce cholecystokinin, a hormone for bile release, used for this reason in dietetics as appetite suppressant. But pinolenic acid has also been related by some researches to the *Pine Mouth Syndrome*, an unpleasant bitter, metallic taste disturbance that can appear 1-3 days after consumption of Chinese pine nuts and lasts for days or even for weeks, sometimes combined with food aversion and other symptoms. Several other hypotheses, still under discussion, are: rancidity due to inadequate processing, storage, and packaging, or, most likely, irritating terpenoid compounds from mingled inadequate, inedible local pine seeds (*P. armandii*, *massoniana*) (Mostin, 2001; Destailats *et al.*, 2010; Munk, 2010; Moeller, 2010; Zonneveld, 2011). Currently, the admixture of *P. armandii* seeds, unfit for human consumption, has been pointed out as the most probable cause of the syndrome (EC, 2011).

Although it has been shown that the Pine Mouth Syndrome (PMS) is exclusively linked to the consumption of pine kernels from China and from no other geographic origins, this food safety issue, long time underestimated by authorities, has had a huge echo in consumers' fora in internet and therefore a negative impact on commerce of all kind of pine nuts, due to the lack of commercial differentiation between species and countries. Moreover, neither EUROSTAT nor Codex Alimentarius (1993) do differentiate pine nuts from different species, and re-exports among countries hamper the traceability of origin and quality of the product. Often, neither the geographic origin, nor even the biological species of imported pine nuts are reported on product labels – therefore they are difficult to trace by consumers in spite of the disparate range of

prices, qualities and the mentioned health issues. Even European nut distributors confound the species, selling Chinese or Pakistani pine nuts indistinctly as true Mediterranean pine nuts, e.g. labelling them in German with the specific product name *Pinienerkerne* that refers to seeds of the species *Pinie*, exclusive name of the Mediterranean stone pine *Pinus pinea*, versus the generic name *Kiefer* or *Föhre* for any other pine species such as the Asiatic ones (Fig. 2).



**Fig. 2. Commercial lots of Chilgoza pine nuts (left) and Chinese pine nuts (up) labelled in German incorrectly as *Pinienerkerne* (i.e. true "Mediterranean pine" kernels).**

This situation is a clear incompliance with current legal requirements for food labeling and traceability that should cover all stages of food production chains. The *Regulation EC 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety*, approved after the disastrous consequences of the Mad Cow Disease (BSE) epidemic, is based on principles in line with the integrated approach 'From the Farm to the Fork', specifically including transparency, risk analysis and prevention, the protection of consumer interests and the free circulation of safe and high-quality products within the internal market and with third countries (EC, 2002). A recent example of the relevance of this regulation for avoiding foodborne illnesses was the EHEC outbreak in Germany in spring 2011, when back-tracing the food supply chain allowed tracking down the origin of the epidemic to fenugreek seed lots imported from Egypt, discarding other suspects such as Spanish cucumbers.

Without any doubt, also the pine nuts supply chain must fulfil these regulations, identifying the traceable origin of each commercial lot, and especially labelling the correct botanical origin of each product. On this way, recently in June 2012, new reviewed standards were proposed by the UNECE (United Nations Economic Commission for Europe) for pine nut trade, with clear provisions concerning quality, presentation and marking, indicating that commercial packages can contain only kernels of the same species, with the obligate mention of the botanical species name in the product label (UNECE, 2012).

## IV – Conclusions

In order to avoid the foodborne illness Pine Mouth syndrome (PMS) and to resolve the failures

of compliance with current legal regulations, national and regional food authorities currently are developing technical standards and public registers for the pine nut supply chain from forest owners, cone pickers, processing enterprises, storages and traders, and the pine nut processing and trading sector itself is increasingly organized in enterprise cooperatives and industry trade associations that promote standardization and technical innovation. On the other hand, traceability improves not only the quality of the product and processes and provides a geographic identification that helps the final consumers to identify the product, but also hinders the still persisting thievery and black-marketing, and it is essential for organic certification labelling.

As roadmap for the Mediterranean pine nuts sector, major issues are the articulation of regional, national and international associations or cooperatives of forest owners, growers and of the pine nut industry, as well as the implementation of regional and national traceability systems for the whole pine nut production and supply chain, and the putting up of high quality standards in production, processing, and trade in European producers. Further targets might be to improve the product profile for a better protection and marketing, e.g. under a "Protected Geographical Indication" (PGI) brand, as well as Traditional or Organic Food Labels, for true Mediterranean pine nuts of each region.

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