

Caesalpinia spinosa (tara): the sustainable source of tannins

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Abstract

The fruit of the tara tree is evaluated as a sustainable source of tannins and other by-products for the leather industry and other applications in food, pharmaceutical or cosmetics. Taxonomy and growing conditions in nature or in agroforestry farms are described, as well as industrial processes among the value chain from harvesting to international markets. Finally, commercial opportunities for economic exploitation are presented.

Background

Caesalpinia spinosa (Molina) Kuntze, commonly known as tara¹, is a small leguminous tree or thorny shrub. Tara is recognized as a source of high value products from its pods and seeds as tannins based on a galloylated quinic acid structure, used in the leather industry, and gum for food industry. It is also grown as an ornamental plant because of its large colorful flowers and pods.



Photo 1: *Caesalpinia spinosa*. Tree, flowers and pods.

Having its origin in the Andean Region, pre-Incas civilizations used the fruits of the tree to produce dyes for textiles and ceramics, tannins for leather and medicines. Known, therefore, as “Incas green gold”, there is a strategic interest in Peru, Bolivia and Ecuador, supported by international organizations for cooperation, to promote productive processes under environmental sustainability criteria and social benefit.

The tara name comes from Aimara language and means flat because the shape of the pods.

¹ Known names (Jones, 1987 and De la Cruz (2004): “Tara”, “Taya” (Peru), “Guarango” (Ecuador), “Cuica”, “Serrano”, “Vinillo”, “Acacia Amarilla” (Yellow acacia), “Andean Dividivi”

Synonyms: *Caesalpinia victoria* (H.B.K.) Bentham ex Reiche; *Poinciana spinosa* Molina; *Caesalpinia pectinata* Cavanilles; *Coulteria victoria* HBK, *Tara Spinosa* (Molina) Britt & Rose; *Caesalpinia stulata* (Sandwith) J.F.

Cesar Barriga² resumes this specie as:

- Plastic: it is able to adapt to several climates and soils
- Rustic: it is not exigent and can grow in superficial, acid and low fertility soils
- Multiple uses: the fruit is profitable, fixes the nitrogen, produces pollen and nectar, and can grow in agro-forestry systems together with other crops.

Due to its wildness, there exists a variety of plants according the regions and the living conditions, thus the content of tannins can vary from 30% to 80%. Currently, institutions and universities carry out researches to characterize the genetic variability³.

Distribution and habitat

Caesalpinia spinosa can be found growing throughout northern, western and southern South America, from Venezuela to Argentina, subtropical and semitropical regions between 4° to 20° South latitudes. It has been introduced in dry parts of Asia, the Middle East and Africa and has become naturalized in California.

Normally tara grows in areas with a yearly rain of 400 to 1,100 mm, and on sanded or degraded soils. It is a wild tree, normally isolated, but sometimes, can form small forests. Generally resistant to most pathogens and pests, it lives between 0 and 3,000 meters above sea level. Trees begin to produce after 4–5 years. If well irrigated, they can continue to produce for 80 years, though their highest production is between 15 and 65 years of age.

2.3. Botanic characteristics

<u>Taxonomic classification by USDA⁴:</u>		
Kingdom	<i>Plantae</i>	Plants
Subkingdom	<i>Tracheobionta</i>	Vascular plants
Superdivision	<i>Spermatohyta</i>	Seed plants
Division	<i>Magnoliophita</i>	Flowering plants
Class	<i>Magnoliopsida</i>	Dicotyledons
Subclass	<i>Rosidae</i>	
Order	<i>Fabales</i>	
Family	<i>Fabaceae</i>	Pea family
Genus	<i>Caesalpinia</i>	Nicker
Species	<i>Caesalpinia spinosa (Molina) Kuntze</i>	Spiny holdback

Industrial processes

The fruit of tara tree and its derivates have a high interest in a number of industries and, thus, a great worldwide economical potential for commerce. The properties of pods and seeds result in a sustainable and quality raw material for several applications.

² Cesar Barriga: PEBAVI – Peru. Personal interview in June 2010

³ RAPDs (Random Amplifies Polymorphic DNAs) molecular makers is the most common technique to characterize the genetic variability.

⁴ United States Department of Agriculture (USDA). Natural Resources Conservation Services. Plants Profile. *Caesalpinia Spinosa (Molina) Kuntze*. (Date of consultancy December, 13, 2009) <http://www.plants.usda.gov/java/nameSearch>

The fruit of tara contains 60-64 % of pods, 34-38 % of seeds and 2 % of non-valuable residues of its weight. Figure 1 shows the industrial flow chart of by-products obtained from tara fruits.

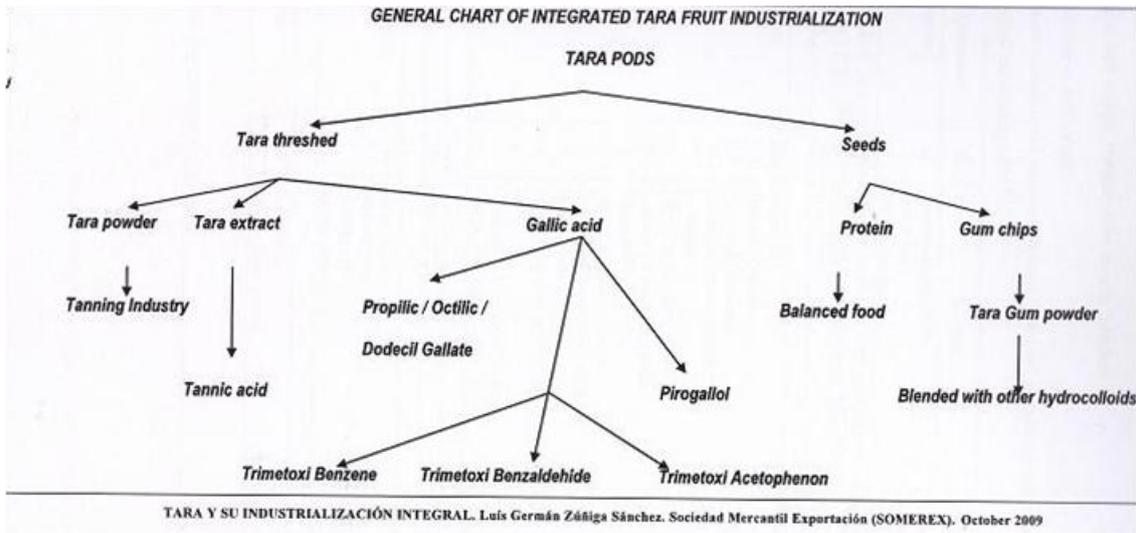


Figure 1: Industrial flow chart of by-products obtained from tara fruit

The current source of tara is mainly natural forests from the Andean region of South America where some agro-forestry exploitations are introduced. Peru is the main area for sourcing tara fruits to obtain tannins followed by far by Bolivia, Chile, Ecuador and Columbia.

The tara supply chain stars from planting the tara tree seeds in agro forestry farms or from harvesting the fruits from wild trees in natural forests. Much of the tara production consists of wild collection, thus, a major problem comes from the quality differences between collected tara and cultivated tara.

The actors of the production and supply chain are those that are involved in the trading process, from farming, harvesting, collecting, transforming and trading the product and the final users.

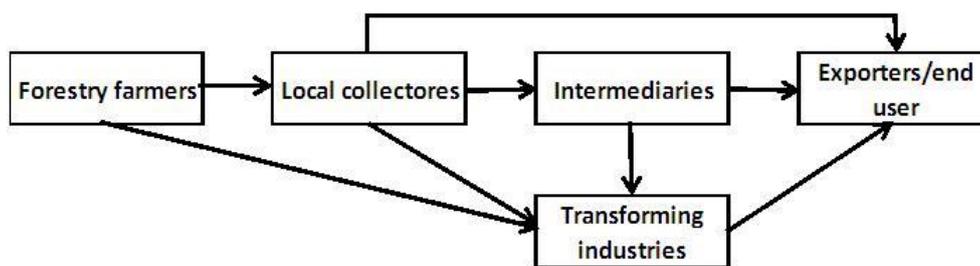


Figure 2: supply chain of tara products

Currently, the major source of tara pods are wild forests and, only in certain areas, tara pods come from forestry farmers.

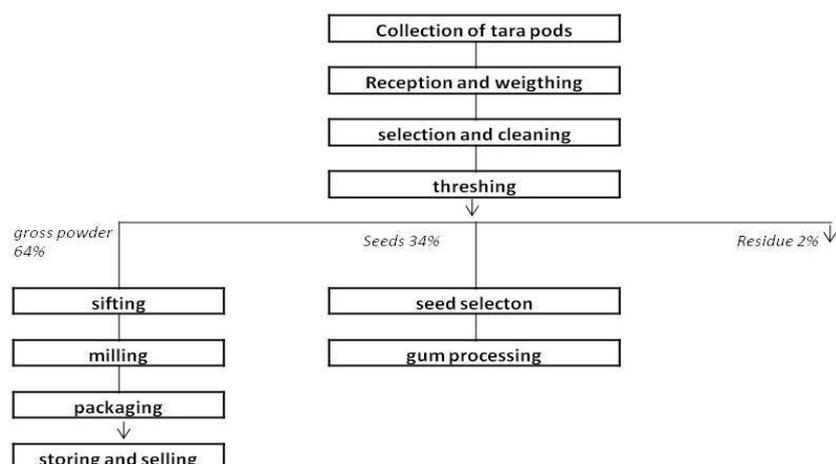


Figure 3: Tara fruit processes

The pods are threshed and the seed separated. Tara powder is obtained by simply mechanically milling and sifting the gross powder.

The tara powder is a fine (100 to 200 mesh) yellowish sawdust.

The leather industry appreciates the tara powder as a source of vegetable tannins to obtain light colors, with good light fastness, and full and soft leather articles, with a firm and smooth grain. Tara is easily soluble in water and do not contain color substances like other vegetable tannins.

Tara powder can be used to tan all kind of hides and skins and to re-tan chrome tanned leathers to improve the grain-tightening. The main application is in the manufacture of leather for car seats. The general specifications for commercial tara powder for tanning application are:

Tannin content	min. 48%
Water content	max. 13 %
pH (at 6.9°Bè)	3 – 4

There are, however, some difficulties of the tara tannin when compared with other vegetable tannin extracts:

- High concentration of insoluble solids (tara powder contain high quantities of cellulosic compounds from the tara pods if tannins are not extracted and concentrated)
- Tanning effect limits when tara tannin is the single compound for tanning. Hydrolyzing vegetable tannins cannot increase the shrinking temperature.
- Easily produces complexes with iron and other metals and form dark spots on the leather when is contaminated.

To obtain tara extract, the tara powder should be treated at 65-70°C for 30-40 minutes adding to the powder 4 to 5 parts of its weight with water and washing the liquor 5 times. Then the liquor is

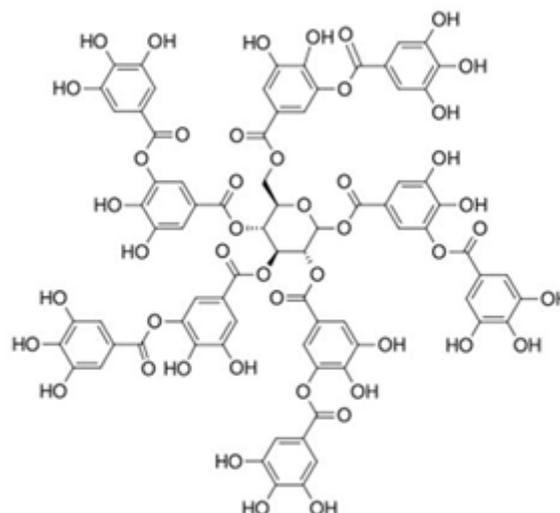


Figure 4: Tannic or Gallotannic acid

purified by decantation and filtration, and concentrated from 2-5° Bè to 11-12°Bè. The powder of tara tannin extract is obtained by atomization.

Tara extract is used to produce tannic acid, and finds valuable applications in the food and beverage industries, to clarify and give astringency to wine, tea, coffee, cacao, beer and other food.

Recent investigations demonstrate that tara tannin and its derivatives have excellent properties as antioxidant agents to prevent cardiovascular diseases⁵. Also, they have astringent properties with pharmaceutical capacity to avoid irritation and harm by reducing protein coagulation. The tannic acid is used as hemostatic to cut down hemorrhages and, mostly, for burning treatment.

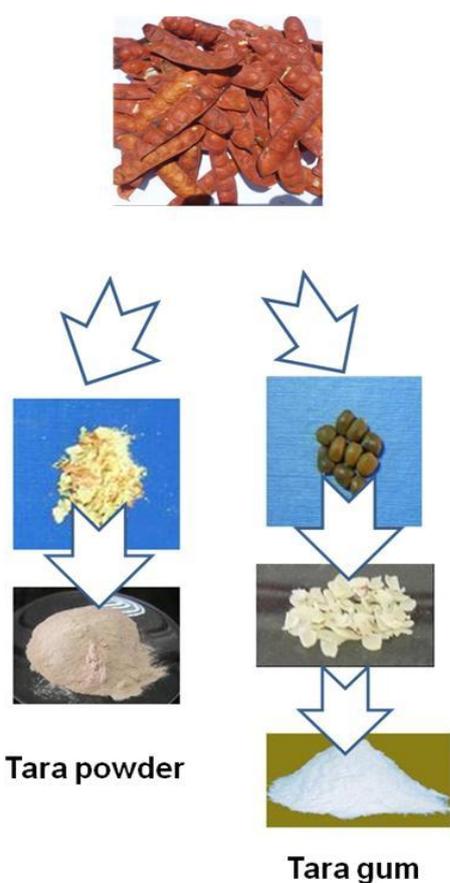


Figure 5: Processes of tara fruit

The gallic acid can be obtained by hydrolysis of tannic acid with sulfuric acid. Chemical hydrolysis is, however, costly and contains impurities, but enzymes, like tannases from bacteria, can be used. It finds valuable applications in the pharmaceutical industry because has biological properties as antioxidant, biocide (virus and bacteria) and analgesic, but also, is used in other industries, e.g. to clarify vegetable fats, beer, or to obtain inks and as analytical reactive.

The tara gum is obtained by milling the endosperm from the tara seeds, after mechanical separation of the husk and the germ. The high viscosity of the tara gum is well appreciated in the food industry and it is an excellent hydrocolloid with good properties as thickener and stabilizer agent used to prepare ice creams, gelatin, powder and liquid soaps, yogurt, sauces like mustard, mayonnaise, ketchup; cream and soft cheeses, bakery, meat, among others. It is stable at pH higher than 3.5, retains water, soluble at cool temperatures, and do not modifies the savors. Further than the food industry, tara gum has also applications in the pharmaceutical industry, cosmetics, mining, paper, textile, oil, and others.

The germ of tara, obtained from the seed cotyledons, has a high content of proteins and it is sold for animal feed and, also, to the pharmaceutical and cosmetic industry as a source of proteins. The germ of tara is also rich in vegetable oils.

Global production

Despite tara tree is native from a wide range of countries according to the World Agroforestry Center⁶, approximately 80% of global production takes place in Peru.⁷ Sources of tara are also

5 M. Skowrya, M. dávila, C. Fabregat, J.C. Castell, M.P. Almajano. Actividad Antioxidante de la vaina de tara. VI Congreso Nacional de Ciencia y Tecnología de los Alimentos. Valencia, 8-10 June, 2011.

6 Agroforestry Database 4.0. World Agroforestry Center. Nairobi. (Date of consultancy October, 24, 2009) http://www.worldagroforestry.org/treedb2/AFTPDFS/Caesalpinia_spinosa.pdf

found in Chile, Ecuador and Colombia and other countries like Bolivia, Venezuela, Cuba and cultivated in China, India, Ethiopia, Kenya and Morocco.

According to Schiaffino⁸, production of tara in 2004 was between 115,000 and 138,000 tons of tara pods, considering that a tree of *Caesalpinia spinosa* is able to produce 50-150 kg of fruit per year, and 20-40 kg. of pods.

It is calculated that 97% of the production was exported as a tara powder or tara gum, therefore, we can make some estimation based on export trade data.

Year	2004	2005	2006	2007	2008	2009
FOB Value USD	13,959,936	16,,705,333	20,956,791	31,756,831	41,326,224	25,317,,943
Delta FOB Value		20%	25%	52%	30%	-39%
Tons	12,878	15,043	15,005	19,918	17,852	17,828
Delta volum		17%	0%	33%	-10%	0%
Price USD/kg	1.08	1.11	1.40	1.59	2.31	1.42

Table 1: Tara exports statistics. Peru.

Table 1 clearly shows how the variability of the market prices has impacted in terms of export value. Since exports in volume (demand) increased from 2004 to 2006, prices rose from an average of USD/kg 1,08 to USD/kg 1,40. During the years 2005 to 2007 the market was consolidated because the highest demand of chrome-free leather for automobile seats.

As production of tara is unable to satisfy the demand, obviously prices go up. In 2007, tara powder exports achieved the highest values, probably the full availability of production, close to 20,000 tons. Export selling prices also increased to USD/kg 2.31 exceeding expectations of demand. As a consequence, during 2008 the export value increased but volume production was stabilized to 18,000 tons.

During 2009 the automobile industry, and also the leather industry in general, suffered the international financial crises and figures were stabilized to volume production of 18,000 tons/year and average price⁹ around USD/kg 1.50.

For better understanding, Figure 6 compares the trends of the export value in Peru during the years 2004 to 2009 compared with the progress of the production volume.

7 Tara *Casealpina spinosa*. Market Survey. Compiled by Swiss Import Promotion Programme (SIPPO) by ProFound – Advisers In Development 2008/2009.

8 Schiaffino, JC. Estudio de mercado de la tara. Perú Programa Desarrollo Rural Sostenible, GTZ, Universidad del Pacífico, GOPA. 2004

9 Average price is the mix price for tara powder and tara gum.

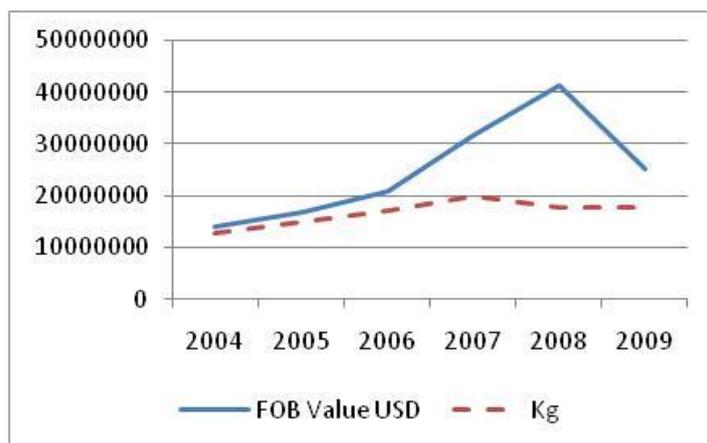


Figure 6: Development of tara exports from Peru comparing value and volume

Figure 8 compares the yearly increase of FOB value of the export trade of tara products and the progress of volume. While the exports in 2007 increased in demand, the market reacted negatively to the price increase. Prices went down in 2009 and production was stabilized.

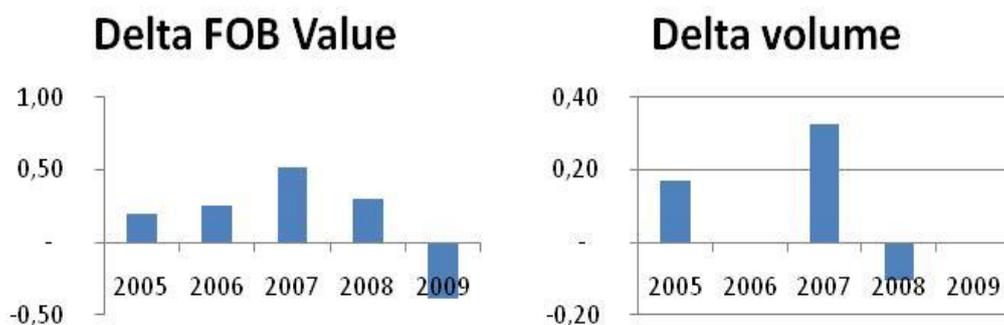


Figure 7: Tara exports in Peru. Increases of FOB value and volume

Expectations for the tara production during the next years

Currently, administrations from the three Andean countries project new forestry developments of 4,730 ha and future production of tara powder can be estimated according to the table 2¹⁰.

	Region	Peru	Ecuador	Bolivia
Product ha	7,730	7,500	50	180
t harvested pods	115,950	112,500	750	2,700
t available tara powder	71,889	69,750	465	1,675

Table 2: Estimated tara production. Period 2011-2012

The goals of the development of the tara in the region for 2005 is to double this production figures and exploitation plans are going to be implemented. This is supported with the highest

¹⁰ Mancero L., 2008, La Tara (*Caesalpinia spinosa*) en Perú, Bolivia y Ecuador: Análisis de la Cadena Productiva en la Región. Programa Regional ECOBONA – INTERCOOPERACIÓN, Quito. Quito, febrero 2009. Page 91

demand of tara products in the leather industry, but also for other products with high potential demand, as the gallic acid and vegetable thickeners.

	Region	Peru	Ecuador	Bolivia
Production ha	14,000	10,000	2,000	2,000
t harvested pods	210,000	150,000	30,000	30,000
t available tara powder	15,960	11,400	2,280	2,280

Table 3: Objective of tara production in 2015

From the production point of view, there is enough experience for forestry technical assistance related to forest and forestry management, plagues control and seed selection and reproduction.

There is a demand for Standardization of the technical quality of the products what is under discussion with International Standardization bodies to coordinate quality requirements according the final application.

There is no doubt that the interest and demand of tara products is growing at international levels. However, alternative products are also available, either from other natural species or by organic synthesis. It is important to develop technologies to improve the present offer of tara products, by customizing or improving the quality, but at the right costs for the market.

There is an opportunity for the leather industry in order to replace chemicals and to obtain sustainable process and articles. Tara tannins offer a wide range of advantages if quality and prices fulfill the expectations of the market.

Analysis of tara potential for the leather industry

Table 4 summarizes market issues and tara consumption opportunities for each leather article.

	Footwear	Furniture	Auto	Garment	Gloves	Other leather goods
Market trend	Sustainable growing higher than population growth rates	Stable	Growing	Variable	Growing for specific uses	Stable, growing luxury goods.
Main markets	China, Italy, India, Brazil	Italy, China, Argentina	Germany, Argentina, China, Mexico, Brazil	Spain, China, India, Italy, Pakistan	South East countries, Africa	Spain, France, Germany
Main consumers	Worldwide	Central and North Europe, USA	USA, Europe	Europe	USA	USA, Europe, Japan
Drivers	Comfort, fashion, functionalities	Elegancy, design	Elegancy, comfort	Fashion	Compliance to the end uses	Trademark positioning
Leather features	Soft, waterproof, breathable	Surface resistances, light fastness	Very high technical performances	Soft and lightness	Soft and fastness.	High quality, elegance, natural
Competition materials	Textile and plastics	Textile	Textile	Textile	Textile	Plastics
Tara application opportunities	Low	Medium	High	Medium	Medium	High

Table 4 : Analysis for tara potential for the leather industry

European Policy of Chemicals (REACH)

The European REACH Directive is a great opportunity for the trade of tara tannins in Europe¹¹.

Since 2006 there is a Directive in Europe (CE 1097/2006) concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH).

To point out the most important advantage for tara products, compared with syntans and other vegetable tannins, they are exempted of such Registration as defined in Annex V, #8:

“Substances occurring in nature, if they are not chemically modified, unless they meet the criteria for classification as dangerous according to Directive 67/548/EEC”

According to Chapter 2, “Definitions and general provision”, Article 3, “Definitions”, # 39:

“Substances which occur in nature: means a naturally occurring substance as such, unprocessed or processed only by manual, mechanical or gravitational means, by dissolution in water, by flotation, by extraction with water, by steam distillation or by heating solely to remove water, or which is extracted from air by any means”

Trading in Europe with tara powder or tara tannins extracted with water does not need to incur with tremendous cost required for collecting safety data and register them in REACH.

Conclusion

The fruits of *Caesalpinia spinosa* (tara) are rich in high value hydrolysable tannins for the leather industry and other industrial applications as a hydrocolloid or polyphenol with nutrient properties in food, pharmaceuticals or cosmetics.

It is a sustainable source of tannins for the treatment of hides and skins in the leather process. However, market opportunities depend on ensuring availability and quality consistency among competitive market prices.

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¹¹ Official Journal of the European Union. Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006. L 396/1. 30.12.2006

