

## **Technologic Propection of Bioactive Compounds in Umbu Pulp (*Spondias Tuberosa Arruda*)**

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### **Abstract**

*The Spondias tuberosa arruda is a fairly integrated type and known in the Brazilian semiarid, being present in the food of the population that lives there. About 18 fruits are in the genus Spondias, and it is known that some of them, like umbu, have antioxidant potential and applicability in several areas.*

*In order to evaluate this potential, it is important a detailed study of all possible applications. This study analyzed the survey results for the bioactive compounds (phenolic compounds and antioxidants) present in umbu pulp (*Spondias tuberosa arruda*) through patent applications. To perform the patent search was used the bases of the World Intellectual Property Organization (WIPO), the database of the Brazilian National Institute of Industrial Property (INPI) and the European Patent Office (Espacenet). This prospect has contributed to the knowledge of researches already developed, especially in order to identify the work in the area of use, characterization, possible applications and potential umbu, focusing on the identification of bioactive compounds and how promising and necessary is a research in that area.*

**Key-words:** Phenolic Compounds, Antioxidants, Patents.

## **1. Introduction**

Among the plant species of caatinga biome, the umbu tree (*Spondias tuberosa* Arruda Câmara) stands out for its importance, whether for the fruits or for environmental and sociocultural function that it represents for local population. The fruits are marketed by small farmers in the main cities from northeastern Brazil. They can be consumed fresh or processed, for example as juices, ice cream, jellies, sweets and jams (Cruz; Andrade; Feitoza, 2016).

Umbu tree belongs to Anacardiaceae family. It is a native tree from Brazilian semiarid region of Northeast Brazil, basically characterized by xerophilic plants. The berries are exotic with a pleasant flavor, peculiar aroma and also are a source of bioactive compounds. Nowadays national and international markets have been showing interest in its great commercial potential (Dutra et al., 2017). Brazil is the largest worldwide producer. The country produced about 8094 tons in 2015. Bahia (87%), Pernambuco (5.02%), Rio Grande do Norte (3%) and Minas Gerais (1.7%) are the principal umbu-producing states (Ibge, 2016).

According to Dutra et al. (2017), umbu fruit weight is an important parameter in the fresh marketing, as heavier fruits are also the largest, becoming more attractive to consumers. Generally, fruits weight ranges between 10 and 20 g, which basically consist of 68% of pulp (w/w), 22% of skin (w/w), and 10% of endocarp (w/w). In addition, umbu contains biologically active substances, such as chlorophyll, carotenoids, flavonoids and other phenolic compounds, considered an antioxidant natural source with protection activity or oxidation inhibition from 74.0% to 91.6%, values on the order of synthetic antioxidants reports (Dantas Junior, 2008; Bastos et al., 2016). Thus, both characterization and development of products umbu-based are shown to be interesting options for industry employment.

Table 1 shows some minerals found in different parts of umbu tree. Physicochemical characteristics of pulp are presented in Table 2. The high levels of vitamin C and acidity are the characteristics that stand out the most.

Table 1 - Nutrient Concentration (PPM) in different Parts of Umbu tree (*Spondias Tuberosa* Arr. Câmara).

Nutrient	Bark	Túbera	Seed	Source	Bark,, polp e fruit	Sheet
Iron	415	65	38	325	81	110
Cooper	5	5	5	5	5	6
Manganese	82	12	5	166	9	32
Zinc	41	17	12	35	15	18
Boron	30	36	5	21	15	68
Sodium	548	508	162	360	106	1300
Aluminum	1424	114	40	1255	77	79

Source: Adapted from Cruz, Andrade and Feitosa, 2016.

Table 2 - Comparison of Physical Chemical Analysis of in Natura and Lyophilized Umbu Pulp

Physiochemical Analysis	<i>In natura</i>	Lyophilized
aW	0,974	0,385
Moisture(%)	89,54 ± 0,22	8,43 ± 0,33
pH	2,76	2,46
Acidity (g ac. citric/100g)	15,07 ± 0,09	42,21 ± 6,96
Asches(%)	0,28 ± 0,05	2,91 ± 0,08
Protein(%)	0,08 ± 0,03	1,28 ± 0,02
Lipids(%)	0,38 ± 0,02	0,92 ± 0,03
Total fibers(%)	2,48 ± 0,06	2,54 ± 0,01
Food fiber(%)	0,25 ± 0,01	0,23 ± 0,0
°Brix	10 ± 0,0	5,26 ± 0,05
Vitamin C (mg de AA/100g amostra)	32,86 ± 2,01	57,14 ± 0,0
Carotenoids (%)	0,68 ± 0,12	0,93 ± 0,45

Source: Own Authorship (2021).

Melo (2010) reported that several studies have revealed that skins and seeds of certain fruits exhibit a relevant content of bioactive phytochemicals, whose antioxidant activity is higher than the pulp, such as Ajila (2007) who studied bioactive compounds present in the mango peel, identifying polyphenols, carotenoids, fibers and enzymes. Guo (2003) evaluated the antioxidant power (Frap method) in the skin, pulp and seeds of 28 different types of fruits consumed in China; and Soong (2004) demonstrated a significant antioxidant capacity and presence of phenolic compounds in fruit seeds.

Thus, residues from the fruit industrial process constitute a rich source of bioactive compounds, making it relevant to evaluate the antioxidant potential of this material in the perspective of using them in food products, as inhibitors of lipid oxidation, in order to replace or reduce the use of synthetic antioxidants, since the safety of these additives has been questioned.

In this context, antioxidant action of citrus seeds (Bocco, 1998); apple peel (Wolfe, 2003); and grape seeds (Mielnik, 2006) have been investigated. It is necessary to evaluate the world scenario regarding the bioactive compounds present in fruits, in particular, of the *Spondias* genus, in order to obtain a greater insight into what has already been studied and which areas require research.

For Souza et al. (2018), fruits are considered the main sources of vitamins and bioactive compounds. Among these, carotenoids and phenolic compounds have been associated with antioxidant capacity, where phenolic compounds stand out, which have an aromatic ring with one or more hydroxyl groups as functional groups, the greater antioxidant activity of fruits is due to the presence of phenolic compounds such as polyphenols and flavonoids (Ribeiro et al., 2017).

According to Quintella et al. (2009), technological foresight has significantly contributed to the generation of long-term policies, strategies and plans, in addition to the foundation in decision-making processes related to research, development and innovation (RD&I). For technological prospecting, a format Important to speed up searches in patent bases is the International Patent Classification (IPC), in which patents are classified according to their application. They are divided into 08 sections, 21 subsections, 120 classes, 628 subclasses and 69,000 groups (Serafini et al, 2011).

Studies related to the characterization of bioactive compounds and antioxidant activity of tropical, semi-arid and exotic fruits are being carried out timidly, and further studies are needed regarding the genus *Spondias*, especially *Spondias tuberosa* Arruda Câmara, whose study is still scarce. Thus, the present work aims to analyze the research results related to the technological prospection of bioactive compounds (phenolic compounds and antioxidants) present in umbu pulp based on documents available in the patent application filing bases.

## **2. Methodological Procedures**

In order to develop this technological prospection, an analysis was performed on documents available in Brazilian (National Institute of Industrial Property/INPI), European (European Patent Office/Espacenet/Worldwide) and worldwide (World Intellectual Property Organization/WIPO) databases. Keywords applied in the research were “umbu” and the scientific name of the genus of this

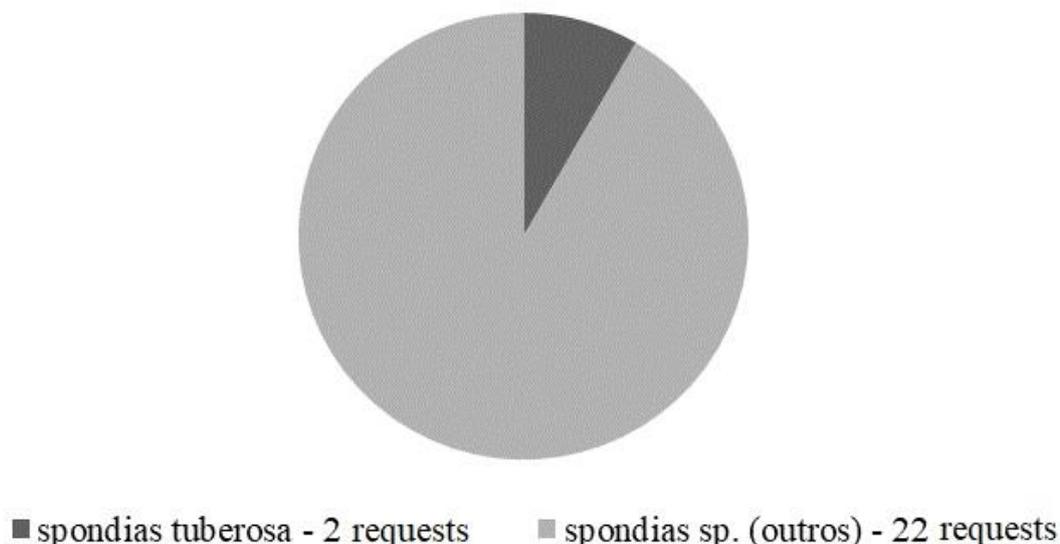
species, “spondias”. In all databases, the same characters were typed, using the search fields “title” and/or “title and abstract”.

Results were expressed by frequency of International Patent Classification (IPC) and the country of origin. This survey was managed in June 2016.

### 3. Results and Discussion

According to keywords described, searches were performed in the proposed patent databases. 24 patent documents were found at Espacenet, using the word “spondias” in the “title or abstract” field. All patents were individually analyzed in order to identify which were related to the desired species (*Spondias tuberosa*). Also the year of publication was valued, as well as the most frequent IPC codes with the main of understanding which studies have been achieved about fruits from that group. Figure 1 shows requests deposited in Espacenet, which only two were related to umbu.

Figure 1 – Requests Referring to the Search “Spondias” at “Title or Abstract” Field in Espacenet Base



Figures 2, 3 and 4 show the frequency of publication of patent filings referring to the "spondias" search in the "title or abstract" field, according to the filing country, the year of publication and IPC, respectively, in Espacenet database.

Figure 2 – Frequency of Deposits in Espacenet Base during the Studied Period

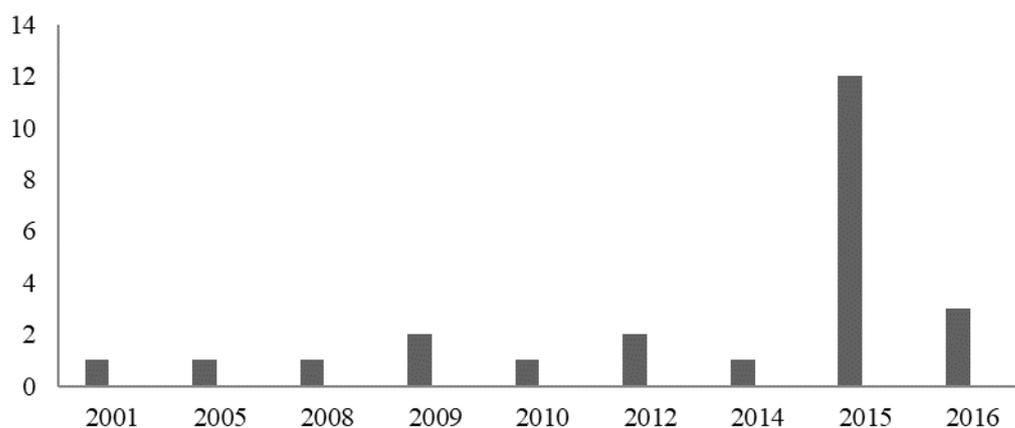


Figure 3 – Frequency of Patents According to the Type of Application in Espacenet Database (Where WO Refers to the World Intellectual Property Organization, When the Institution Chooses to File through the Patent Cooperation Treaty - PCT)

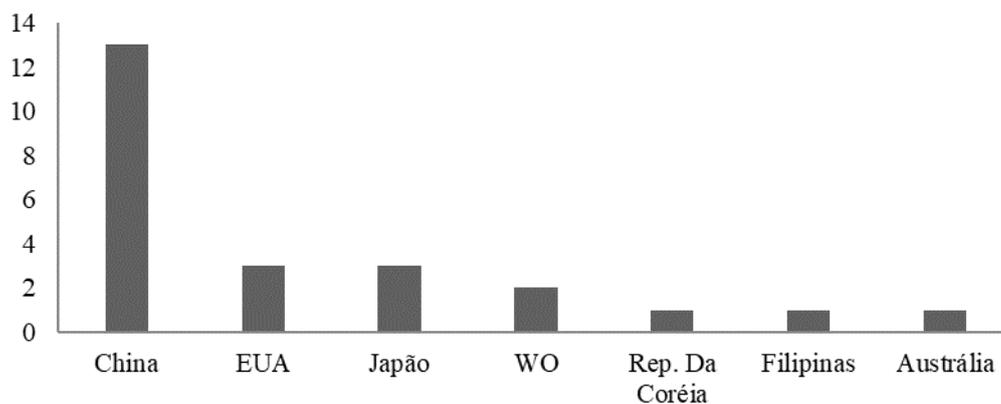
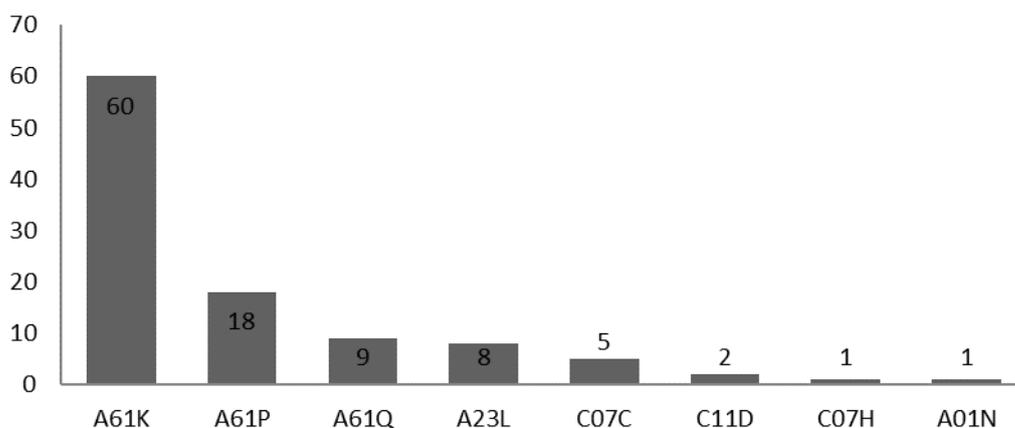


Figure 4 – IPC Codes with Highest Concentration of Patents in the Espacenet Base



Patent applications' main country of origin was China (54%) and the number of patents went through a sharp increase in 2015, representing half of survey patents. The most recurrent IPC codes were A61K: A (human needs), followed by A61 (medical science, veterinary science or hygiene); and A61K (preparations for medical, dental or hygienic purposes).

When adding the species to genus as “spondias tuberosa” also in the “title or abstract” field, as well as searching for “umbu” in the same field, only the same 02 works were found, both published in 2016 with the most recurrent IPC C07C, referring to acyclic or carbocyclic compounds.

Search in Patent Scope database was then started with the word “umbu” in the “advanced search” field. 36 patent applications were found between 2000 and 2016. 09 of them did not refer to the *Spondias tuberosa* fruit, but probably to some word or code in the field of computing. Figures 5, 6 and 7 show the frequency of deposits by year, country and IPC for this search.

Figure 5 – Time Evolution of Patent Application during the Studied Period in WIPO.

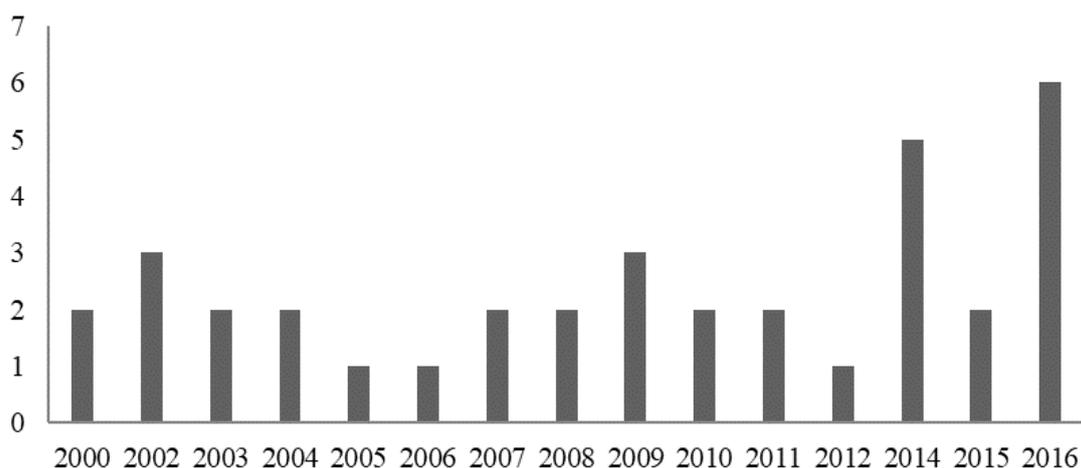


Figure 6 – Countries of Origin in the WIPO Worldwide Base

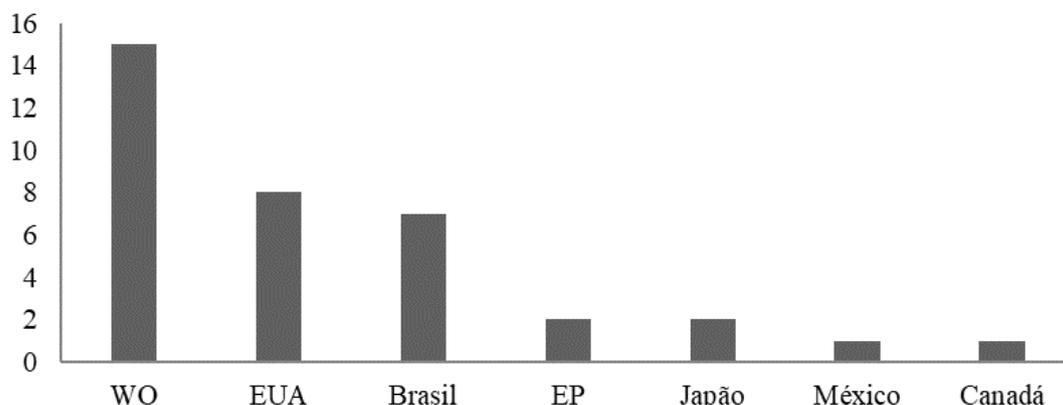
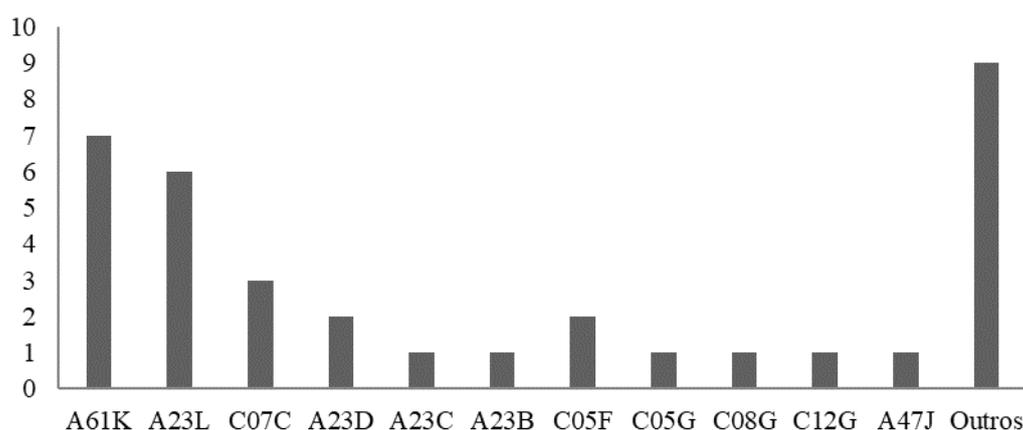


Figure 7 – International Patent Classification in WIPO Worldwide Base



It is known that a single patent contains multiple classifications (IPC codes), according to the subject it addresses. For searches in the WIPO database, the predominant classification in the work was considered the one that mostly represents the subject of the request.

World Intellectual Property Organization (WIPO) holds the largest number of patents, followed by the United States and Brazil. The highest number of registrations was between 2014 and 2016. The most recurring international classification was also A61K followed by A23L (food, food or non-alcoholic beverages).

Next search step was conducted by using the word “spondias tuberosa” in the “advanced search” field. Fourteen patents were found, filed between 1998 and 2016. Following the same trend, Table 3 shows the peak applications in 2016. This indicates the growing social interest in the area. WIPO, Brazil and USA appear as the countries with the highest number of orders and A61K the most recurrent CIP, followed by C07C.

Table 3 – Country of Origin, IPC and Time Evolution in WIPO Database by Searching "Spondias Tuberosa" in the "Advanced Search" Field

Country of origin							
WO	Brazil	USA	Canada	Japan			
5	3	3	2	1			
IPC							
A61K	C07C	A23L	A61P				
9	3	1	1				
Time evolution							
'98	'06	'07	'08	'09	'11	'14	'16
3	2	1	1	1	1	1	4

In INPI base, a basic research was carried out in the patent database in the abstract field, the keywords “Spondias” and “umbu”. For “Spondias” search, 10 patent applications filed between 1996 and 2014 were found, two referring to umbu (*Spondias tuberosa* Arruda Câmara). Both classified by the most recurrent IPC, A61K.

When searching “umbu” in the summary field, 06 requests were found, one of which was used with other fruits for the production of recycled paper. The other 05 works were submitted between 2010 and 2014 and covered section A (human needs) with a focus on food or food products; its processing, not related to other classes and household articles.

Two patents were filed by Universidade Estadual Paulista Julio de Mesquita Filho in partnership with the University of Geneva. Both referred to the only patent application filings related to the study of bioactive compounds in umbu pulp, as nutraceutical and/or functional foods and cosmetics. These same patents were also found in WIPO and Espacenet databases. In the works, the inventions refer to the process of extraction and isolation of active substances, present in the fruit pulp, which presents an action to inhibit the enzyme acetylcholinesterase and the other referred to the potential of the antioxidant activity, conferring the chemopreventive activity of umbu pulp.

#### **4. Final Considerations**

Results show that there is a lack of studies about umbu and its parts (pulp, peel and seeds), regarding that it is an abundant fruit in Brazilian semiarid region. Through the registration of patent deposits in the Brazilian, European and worldwide bases, it was noticed that few studies about *Spondias tuberosa* Arruda Câmara, scientific name of umbu, were focused on food or cosmetic purposes. Only 02 studies dealing with the identification of bioactive compounds and requests were filed by the same authors.

Considering the great potential of umbu as an antioxidative source, it is important and necessary new works which could bring a deeper study around bioactive compounds present in this fruit and, considering the rarity of research in this subject, this area shows promise.

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