DATLAS

INTELLIGENT DIVERSIFICATION:

Possibilities for the sophistication and diversification of the Oil Palm industry in Colombia

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MINCOMERCIO INDUSTRIA Y TURISMO

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SUMMARY

This document presents different possibilities to improve the export position of the Oil Palm industry based on the diversification of its markets and the development of more sophisticated goods such as oleochemicals, phytonutrients and other derivatives.

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Bancóldex presents this intelligence report as an input for the decision-making of entrepreneurs and trade industries.

Thus, Bancóldex, as a partner of entrepreneurs who dare to grow, presents the following proposal of Intelligent Diversification for the Oil Palm industry in Colombia.

Intelligent Diversification is understood as the ability of companies to take advantage of their technical knowledge to:

i. Diversify international markets

ii. Seize opportunities in the domestic market

iii. Innovate and diversify with more sophisticated products

These intelligence reports are generated from Datlas Colombia [1] **(http://datlascolombia.bancoldex.com)**, as well other Bancóldex's sources of information.

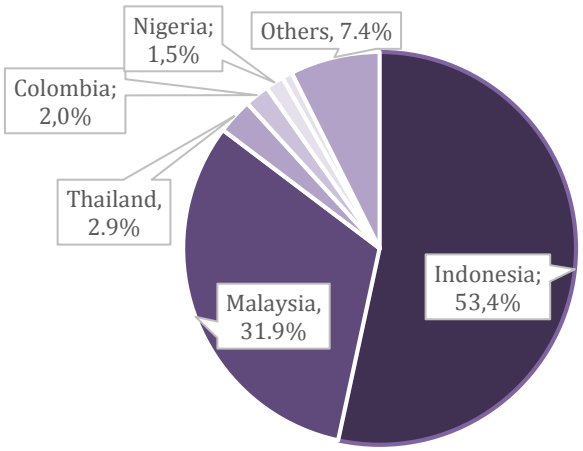
1 The exports information contained in this report is based on the Atlas of Economic Complexity for Colombia - Datlas Colombia, a tool developed by the Trade, Industry and Tourism Sector and the Center for International Development at Harvard University (CID). Due to the methodology used by Datlas Colombia, which makes a special geographical allocation of the numbers, in some cases the information reported does not match the one published by DIAN or DANE. For more information see http://datlascolombia.bancoldex.com.

I.Characterization of the Oil Palm industry in Colombia

a) Current status of the Oil Palm industry in Colombia

In 2015, Colombia positioned itself as the world's fourth largest producer of crude palm oil and first in the Americas. Colombian crude palm oil production for this year was estimated in 1.2 million tons, representing 2% of the world's production of 62.6 million tones[2]. Figure 1 shows the main crude palm oil producing countries.

Figure 1. Distribution of the world's crude palm oil production for 2015



Source Statistics Year-Book Fedepalma, own calculations

2 Anuario Estadístico, La agroindustria de la palma de aceite en Colombia 2011-2015 [Informe] / aut. Fedepalma. - Bogotá D.C. : Fedepalma, 2016.

b) Status of Colombian exports for the Oil Palm Tree industry.

During the year 2015, Colombian exports of products belonging to the value chain of the Oil Palm industry represented 3.2% of the country's total exports. Exports of this industry were mainly focused on the links of i) Derivatives and ii) Oils, which represented 75.6% of the total exported. Therefore, Table 1 shows the Colombian exports of the different links of the Oil Palm in 2015, their share in the industry, in the country's and the world's total exports.

Table 1. Exports of the oil palm industry in Colombia, 2015

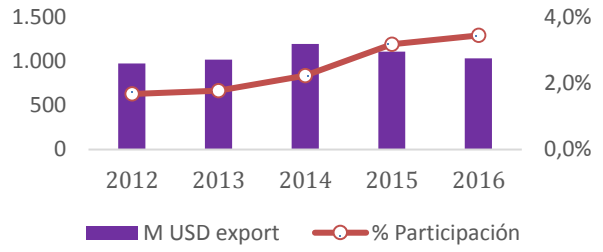
LINK [3]	EXPORT. USD MILLION	% EXPORT INDUSTRY	% TOT EXP. COL	% EXPORT COL / EXPORT WORLD
Oils	$ 338.97	30.6%	0.97%	1.094%
Food	$ 241.86	21.8%	0.69%	0.218%
Derivatives	$ 498.96	45.0%	1.43%	0.532%
Extraction	$ 2.26	0.2%	0.01%	0.310%
Phytonutrients	$ 2.50	0.2%	0.01%	0.133%
Oleochemicals	$ 23.56	2.1%	0.07%	0.087%
Total	**$ 1,108.11**	**100.0%**	**3.18%**	**0.417%**

Source DANE, own calculations

c) Exports evolution of the value chain main links of the oil palm industry 2012-2016.

Exports of the different links of the Industry registered a positive performance in the period 2012-2014 and a decrease in the period 2014-2016. In percentage terms, the share of exports moved from 1.68% in 2012 to 3.44% in 2016[4] of Colombia's total exports, as shown in Figure 2.

Figure 2. Evolution of exports and participation of exports of the industry, 2012-2016

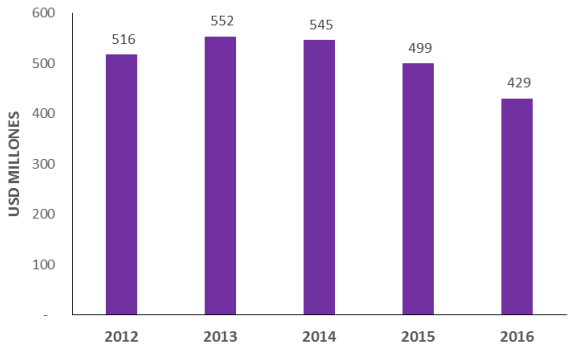


Source DANE, own calculations

3 For further details on the value chain of the Oil Palm industry see annex 2. Export Value Chain of the Oil Palm Industry.
4 This trend might be explained by the total decrease of the Colombian exports in the years 2015 and 2016 given the global fall of oil prices.

According to figure 3, exports of the Derivatives link registered an annual average fall of 4.5% during the period 2012-2016.

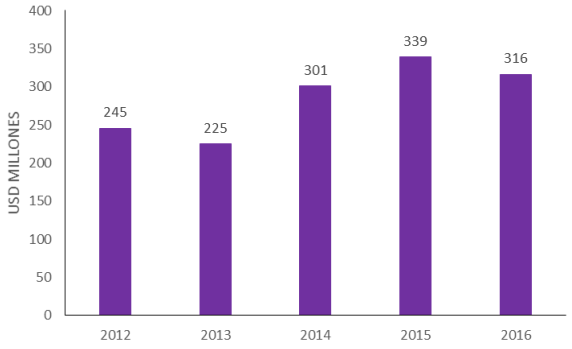
Figure 3. Evolution of exports of palm tree Derivatives, Colombia 2012 -2016



Source DANE, own calculations

On the contrary, according to Figure 4, the Oils exports annual average growth was 6.6% in the same period.

Figure 4. Evolution of exports of Palm Oils, Colombia 2012 - 2016.



Source DANE, own calculations

d) Sophistication of the industry links.

Datlas Colombia allows to understand the sophistication of the products developed by all industries in the world. Analyzing the degree of export sophistication is crucial for Bancóldex, given that multiple studies conducted by Ricardo Hausmann [5], Eduardo Lora [6], among others, have shown the existence of a direct relationship between economic growth and the level of economic complexity of exported goods. In fact, according to Datlas Colombia, "productivity and economic growth of a region depend on companies being able to successfully produce and export goods and services that require more complex skills and knowledge, i.e. more diverse and exclusive"[7]. Sophistication is measured using the complexity variable. To illustrate, Table 2 shows the complexity indexes for 2014 according to the sectors classified by Datlas Colombia.

Table 2 Complexity index 2014.

INDUSTRY	COMPLEXITY
Machinery	2.28
Electronics	1.92
Transportation vehicles	1.79
Chemicals and plastics	1.67
Metals	1.44
Stone and glass	1.26
Veg., food and wood	-0.25
Textiles and furniture	-0.36
Minerals	-0.82

Source Datlas Colombia

5 Director of the Center for International Development, Harvard University.

6 Senior Fellow of the Center for International Development , Harvard University. Former Chief Economist of the Interamerican Development Bank.

7 http://datlascolombia.bancoldex.com/#/about/glossary

According to the information provided by Datlas Colombia, the average complexity of the Oil Palm value chain links is 0.70. According to Figure 3 the Oils link (it economic complexity index of -2.59) has a lower complexity than the Extraction link (it economic complexity index is -1.92). Phytonutrients is the most sophisticated link with a complexity index of 2.40. Likewise, **it seems to be a relationship between the level of sophistication and the average sales price per ton in international markets of the different links** [8] . For example, the Phytonutrients link, has a higher international sales price, with an average price of USD $18,306 per ton, which is 36 times higher than the average registered price for the Extraction link.

Table 3. Sophistication degree comparison (2014) and average price (2015) of the Oil Palm industry value chain links.

LINK	COMPLEXITY (SOPHISTICATION)	PRICE (USD / TONS)
Oils	-2.59	830
Food	0.20	2.696
Derivatives	1.21	9.005
Extraction	-1.92	509
Phytonutrients	2.40	18.306
Oleochemicals	1.57	1.577
Average links	0.70	5.044

Source Datlas Colombia and World Bank, own calculations

8 This relationship is built from a correlation analysis. The Pearson correlation coefficient of this relation (complexity / price) is 0.71. However, further studies are needed to confirm it.

e) Export specialization of the Oil Palm industry links, 2014

In order to understand the specialization degree of Colombian exports for the Oil Palm industry value chain links, this Report uses the Revealed Comparative Advantage (RCA) index developed by Balassa[9] and presented in Datlas Colombia for each export product. The RCA index compares the export of a product in a certain place (in this case Colombia), with the export of that same product in the global market.

The RCA index is a practical indicator to estimate the export specialization of a product in a specific location. When the RCA value is greater than 1, it is understood that Colombia has a share in the global market of that product greater than what would correspond to the amount of all its exports. Thus, it is inferred that the country is relatively specialized in the export of that good.

When analyzing the average RCA for the Oil Palm industry value chain links (Table 4), it can be seen that the Oils, Derivatives and Extraction links have a Revealed Comparative Advantage equal to or greater than 1. This allows to infer that Colombia is relatively specialized in these groups of products. However, this level of RCA has not yet been reached for Phytonutrients, the most sophisticated link with the highest price per ton ever reached worldwide.

Table 4. RCA of the Oil Palm industry links, exports and links price in Colombia, 2015.

LINK	RCA	USD MILLIONS EXPORT.	PRICE (USD / TONS)
Oils	4.74	338.97	830
Food	0.94	241.86	2.696
Derivatives	2.30	498.96	9.005
Extraction	1.34	2.26	509
Phytonutrients	0.58	2.50	18.306
Oleochemicals	0.37	23.56	1.577
Average / Total	1.71	1,108.11	5.044

Source: World Bank, own calculations

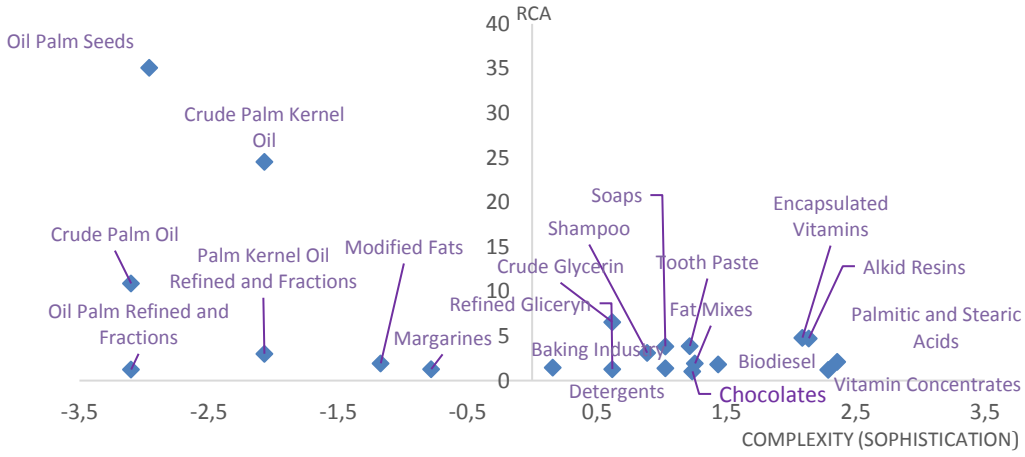
9 Balassa, B. (1965), "Trade Liberalisation and 'Revealed' Comparative Advantage", The Manchester School, 33, 99-123.

II. Identification of star products in the Colombian Oil Palm industry and diversification opportunities in the international and domestic markets.

a) Star products of the Colombian Oil Palm industry

Star products are those goods developed by Colombian companies that have a RCA level above 1. When analyzing the export products of each link, there are several goods regarding which the country obtains a high degree of export specialization. In fact, **out of 40 analyzed export products of the Oil Palm industry worldwide, Colombia has 21 which RCA values are above 1**. Figure 5 shows those products in which Colombia has RCA higher than 1 according to their sophistication degree. These products can be divided into two broad categories: the ones with low sophistication level (7 products to the left of the Y axis), and those of medium and high sophistication level (14 products to the right of the Y axis).

Figure 5. Products with RCA greater than 1 and level of sophistication



Source Datlas Colombia, own calculations

The analysis in figure 5 shows that **the country has developed world-class industries in the manufacturing of highly sophisticated products such as vitamins, palmitic and stearic acid and chemical resins**. Likewise, it can be noted that the exports specialization has mainly focused on the development of low sophistication level products such as oil palm seeds and crude oils. Finally, the existence of a critical mass of companies[10] with productive knowledge in all the links of the industry, allows to infer that new more sophisticated products can be develop.

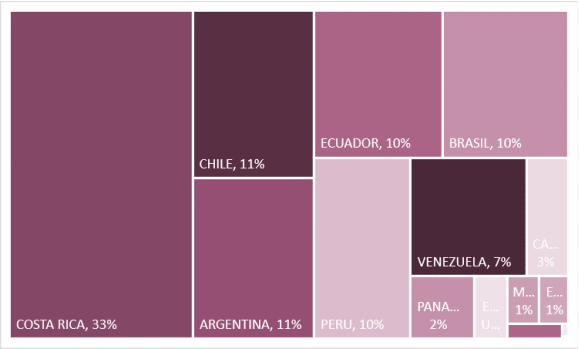
In the next section we will analyze some of the destinations to which the Colombian Oil Palm industry exports its most sophisticated products with RCA higher than 1 and the main international markets they could reach.

b) Possibilities of diversification of export markets of palmitic and stearic acid[11]

Exports of palmitic and stearic acid represented USD 4.2 million in 2015. These exports were sent to the Central American and South American markets. As can be seen in Figures 6 and 7, the destinations to which the domestic industry exports these products are not large international markets.

Figure 6. Export markets for palmitic and stearic acid, 2015

Colombian exports USD 4.2 million.



Source: DIAN, own calculations

Figure 7. International import markets for palmitic and stearic acid, 2015

Imports in the world USD 765 million

Source: Observatory of Economic Complexity

10 Bancóldex has identified 236 companies incorporated in Colombia operating in the different Industry links.

11 The palmitic and stearic acid industry refers to the products export under tariff heading 291570.

c) Market diversification possibilities for vitamins concentrates and mixtures [12]

Colombian exports of vitamins concentrates and mixtures represented USD 1.7 million in 2015. The global market for this product is USD 800 million, of which Colombia produced 0.21%. When comparing figures 8 and 9, it can be seen that Colombian exports of this good do not reach the main international markets: The United States, Canada, and the United Kingdom.

Figure 8. Export markets for Colombia of vitamin concentrates and mixtures, 2015

Colombian exports USD 1.7 million

Source DIAN, own calculations

Figure 9. International import markets for vitamin concentrates and mixtures, 2015

World's imports USD 800 million

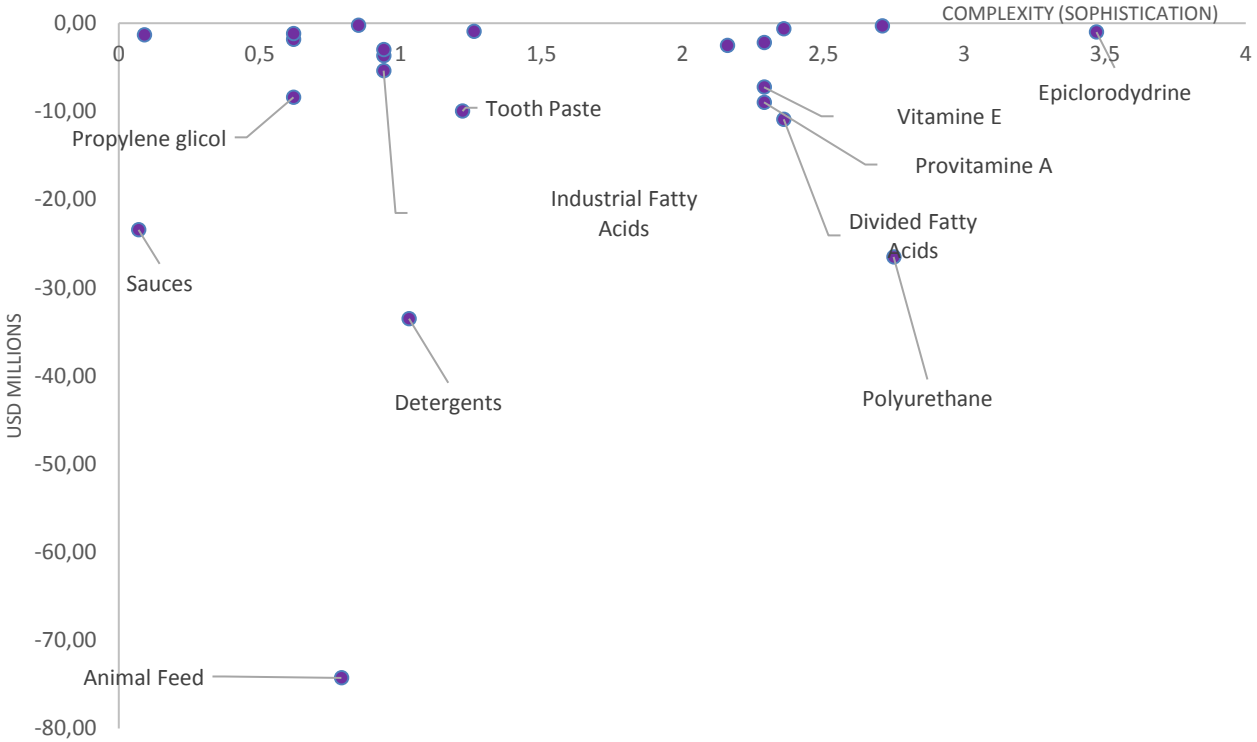
Source: Observatory of Economic Complexity

12 The industry of vitamins concentrates and mixtures refers to the products export under tariff heading 293690.

d) Possibilities to develop sophisticated industries in which Colombia is highly dependent

The Colombian trade balance of the Oil Palm industry in 2016 was negative by USD 100 million. This number indicates that there are multiple companies in the country in need of products that could be developed in the domestic market and that are currently imported. The development of industries focused on the domestic market of animal feed, detergents, polyurethanes, acids and fatty alcohols and vitamins, might benefit the country given their sophistication levels and impact on the trade balance. Figure 10 shows the Colombian trade balance of products with a complexity degree greater than 0 (medium and high sophistication).

Figure 10. Colombian Oil Palm industry deficit trade balance, 2015



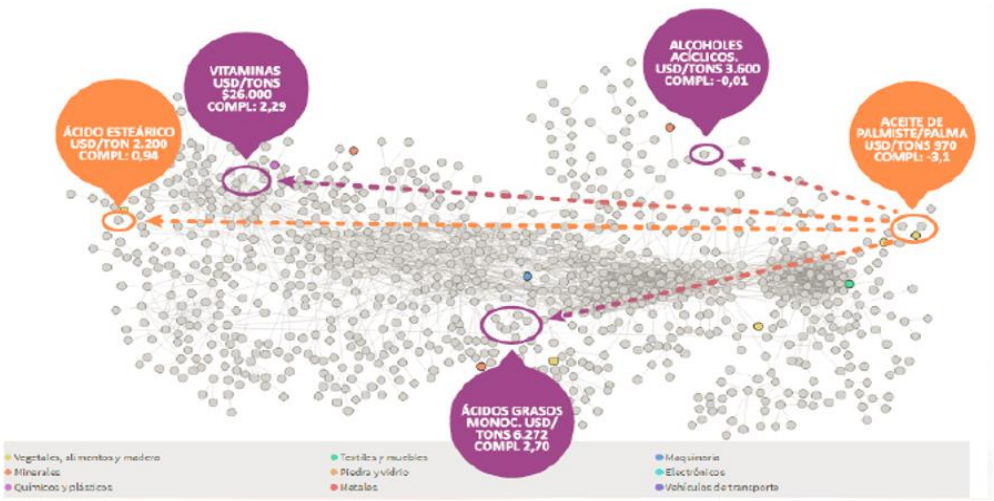
Source Datlas Colombia and DIAN, own calculations

III. Opportunities to innovate and diversify towards higher sophisticated products.

a) Map of palm oils products and other more sophisticated goods

Datlas Colombia and the Atlas of International Economic Complexity allow to identify products that share similar productive capacities (knowledge, technologies, institutions, among others). These results generate a network connected by pairs of products with high possibilities of being co-exported. This network is graphically represented in a Products Map. The Products Map shows how similar is the knowledge required for the export of the different products. Each dot represents an export product and each link between a pair of products indicates that they require similar productive capacities. Highlighted in color are the exported products with a revealed comparative advantage greater than one (RCA> 1). Figure 11 shows the Colombian Products Map with some identified opportunities for the elaboration of more sophisticated products made of palm oil. This figure also shows the average global sales price of each selected good and its sophistication level.

Figure 11. Products Map and possibilities of diversification and sophistication



Source Datlas Colombia

According to the Products Map, the links between palm oil (right of the map) and more sophisticated goods belonging to its value chain like phytonutrients (e.g. vitamins) or oleochemicals (e.g. fatty acids, acyclic alcohols and stearic acids) are far from each other (left of the map) and not connected. This means that, in order to generate more sophisticated goods derived from palm oil, new productive knowledge, which the exporting companies that exploit palm oil might not have and are less ubiquitous worldwide, is required.

In order to provide more information on how to develop more sophisticated products from palm oil, the following section contains some technological paths to follow.

b) Technological paths for the development of phytonutrients from palm oil

Phytonutrients are natural chemical compounds related to disease prevention. They fit into different market segments: either as food products ingredients, pharmaceuticals, or as food supplements. Demand of this type of products is increasing at rates above 7%[13], and it is still in an exponential growth phase. It is estimated that, with the increase of the world's population, especially the middle class population in Asia, demand of this type of products will be strongly stimulated[14]. Vegetable oils such as soybean and palm oils are rich in vitamin E and sterols. Specifically crude palm oil is very rich in vitamin E, provitamin A, sterols and squalene. Vitamin E has two chemical forms: tocopherols and tocotrienols, the latter being a more effective way for humans to consume vitamin E. Vitamin E found in palm oil has the advantage of being richer in tocotrienols, unlike vitamin E found in soybean oil, which is richer in tocopherols[15]. There are different technological routes to obtain phytonutrients that companies that have a presence in Colombia could develop in order to sophisticate and diversify their production. Below two of them.

The first technological route is presented in Figure 12 and consists of an alternative pretreatment to physical refining followed by esterification and transesterification treatments. Alternative pretreatment is included because physical refining removes or destroys a great amount of phytonutrients during the bleaching and deodorization processes[16]. Biodiesel obtained from the transesterification is red because of its high levels of carotenoids; however, this red color disappears after the short path distillation process. Based on this process, a base rich in phytonutrients from the bottom of the distillation column, from which tocotrienols and tocopherols (Vitamin E), carotenoids (Provitamin A) and sterols can be extracted, is obtained[17] [18]. This route has the advantage of allowing

13 Phytonutrients Market, Global Trends & Forecast to 2020 [Informe] / aut. Markets and Markets. - 2015.

14 Ibid

15 Carotenos, vitamina E y esteroles en aceites Elaeis guineensis, Elaeis oleífera y sus híbridos [Publicación periódica] / aut. Choo Y.M., Ma A.N. y Yap S.C. // Palmas. - 1998. - 2: Vol. 19. - págs. 79-85.

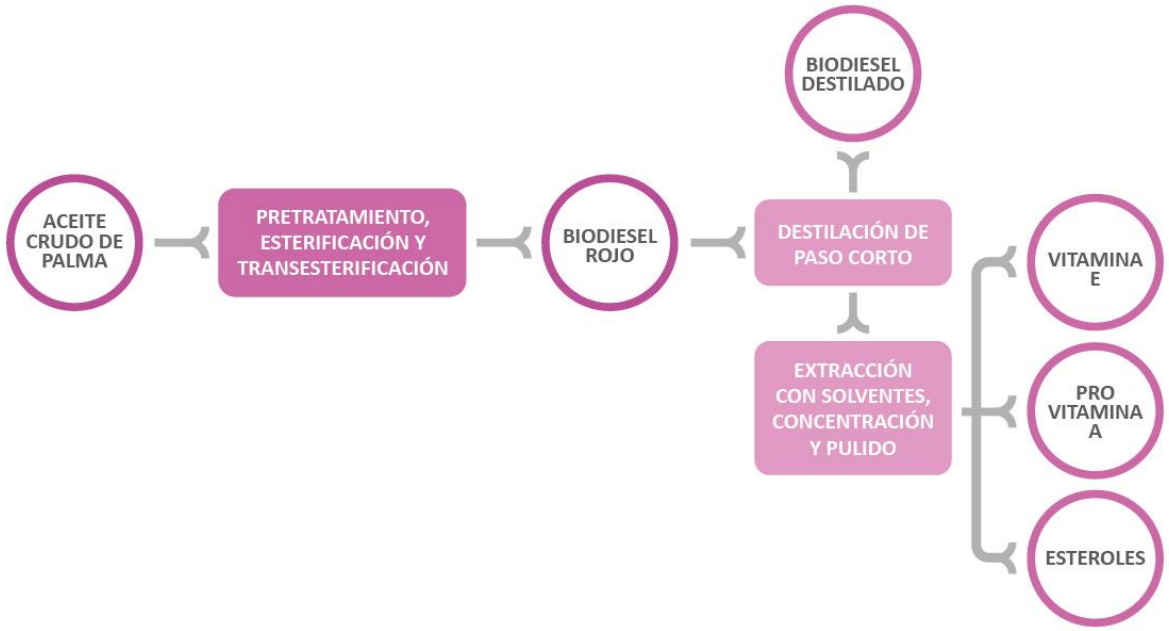
16 Potential source and extraction of Vitamin E From Palm-Based Oils: A Review [Publicación periódica] / aut. Maarasyid Cici, Muhamad Ida Idayu y Supriyanto Eko // Jurnal Teknologi. - 2014. - 4: Vol. 69. - págs.. 43-50.

17 ExcelVite's Patented Biodiesel Plus Technology - Maximizing Economics of Biodiesel Production [Conferencia] / aut. Leong W.H. - Cartagena de Indias: Fedepalma XVII Oil Palm Conference, 2015.

18 Production of high concentration tocopherols and tocotrienols from palm oil by-products [Patente]: EP19890302597 / invent. Top Abdul G. Md. [y otros]. - United States, 31 de marzo de 1989.

the use of the installed capacity of biodiesel producers for transesterification. At the same time the obtained biodiesel is distilled, which solves quality problems related to solid waste that use to appear when the raw material for its production is palm oil[19].

Figure 12. Technological route No. 1 for obtaining phytonutrients[20] from palm oil.



Source: Self made

The second proposed route is the extraction of phytonutrients from distilled fatty acids. There is abundant literature on the extraction of tocopherols and sterols from fatty acids distilled from the deodorization process of the physical refining of different oils[21] [22][23]. In the case of palm distilled fatty acids, these are rich in tocotrienols and tocopherols, sterols and squalene[24]. The procedure described in the patent application of (Muro, 2002) consists on the combination of the chemical esterification

19 Precipitation above cloud point in palm oil based biodiesel during production and storage [Publicación periódica] / aut. Na-Ranong Duangkamol y Kitchaiya Prakob // Fuel. - 2014. - 15 : Vol. 122. - págs. 287-293.

20 Diagrama adaptado de Building plants for biodiesel and co-products [Informe] / aut. Toh T.S. y Koh P.M. - Lipochem (M) Sdn Bhd.: Biofuel Plants, 2008.

21 Potential source and extraction of Vitamin E From Palm-Based Oils: A review [Publicación periódica[/ aut. Maarasyid Cici, Muhamad Ida Idayu y Supriyanto Eko // Jurnal Teknologi. - 2014. - 4: Vol. 69. - págs. 43-50.

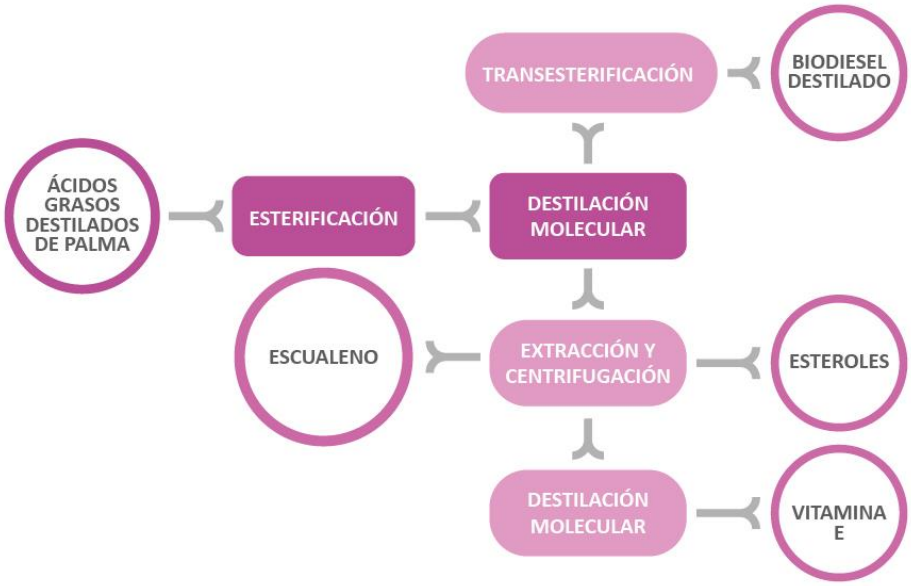
22 Procedimiento de extracción y purificación de tocoferoles naturales y esteroles por esterificación con trimetilol propano [Patente] - WO2002000640A1: WO Application / invent. Muro Eloy. - United States, 3 de Enero de 2002.

23 Process for production of highly enriched fractions of natural compounds from palm oil with supercritical and near critical fluids [Patente]: US8048462B2: US Application / invent. Brunner Gerd [y otros]. - United States, 1 de Noviembre de 2011.

24 Characteristics and properties of fatty acid distillates from palm oil [Publicación periódica] / aut. Yen Ping Bonnie Tay y Yusof Mothar // Oil Palm Bulletin. - 2009. - Vol. 59. - págs. 5-11.

process, along with separation processes to obtain very high concentration vitamin. Figure 13 shows a flowchart of the described procedure.

Figure 13. Technological route No. 2 for obtaining phytonutrients[25] from palm oil.



Source: self made

c) Technological paths for the development of basic oleochemicals from palm oil

In oleochemistry, there are three families of basic oleochemicals from which more elaborated oleochemicals can be obtained[26] [27]. The first one is the Methyl Esters of Fatty Acids, better known as

biodiesel. The palm trade industry in Colombia has been very successful in developing through this type of chemistry a market with great sales potential[28]. Detergents and the other two groups of basic

25 Flowchart adapted from the mentioned invention in (Muro, 2002).

26 Principales tecnologías para la elaboración de oleoquímicos a partir de los aceites de palma y de palmiste. Primera parte: Tecnología para la producción de oleoquímicos básicos [Publicación periódica / aut. Jaimes M. Diana I., Romero P. Carlos A. y Narváez R. Paulo C. // Palmas. - 2003 - 4 : Vol. 24. - págs. 55-70.

27 Principales tecnologías para la elaboración de oleoquímicos a partir de los aceites de palma y de palmiste. Segunda parte: Tecnología para la producción de oleoquímicos derivados [Publicación periódica / aut. Jaimes M. Diana I., Romero P. Carlos A. y Narváez R. Paulo C. // Palmas. - 2004 - 1 : Vol. 25. - págs. 47-66.

28 Experiencia del gremio palmero colombiano en el desarrollo del biodiesel de palma [Conferencia] / aut. Fedepalma // Innovación productiva en circuitos comerciales orientados a la producción y comercialización de biocombustibles. - San José de Costa Rica: Taller IICA, 2014

oleochemicals can be obtained from biodiesel[29 30 31]. The other two groups of basic oleochemicals are Fatty Acids and Fatty Alcohols, which can be obtained from biodiesel or directly from refined oil[32]. The main byproduct of the oleochemicals extraction from vegetable fats processes is glycerin. There are three types of glycerin: crude, technical and pharmaceutical. These types differ in quality, complexity, price and applications. While crude glycerin is a byproduct obtained directly from oleochemical transformations, the other two types are obtained by refining crude glycerin, being the pharmaceutical glycerin a variety with specialized characteristics[33 34]. Among the valuable products that can be obtained from glycerol epichlorohydrin, propylene glycol and 1,3-propanediol [35 36 37] are important. The applications of oleochemicals are diverse, ranging from products for hygiene and personal care, to antifreeze, lubricants, cosmetics and monomers, among others. Uses in the manufacture of paintings[38] [39]and polyurethanes[40] are also noted.

As can be seen in figure 14, oleochemicals can be obtained from refined raw materials by means of a process known as hydrolysis. The resulting product is a mixture of fatty acids corresponding to the raw material fatty acid profile. To obtain commercial stearic acid, the mixture is hydrogenated, which can be fractioned to obtain individual cuts of palmitic and stearic acid. If it is desired to obtain oleic acid,

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29 Boletín Técnico No. 26: Metil éster sulfonado: una generación nueva de surfactantes [Informe] / auto. Rincón M. Sandra., Martínez C. Daniel M. y García N. Jesús A. - Bogotá D.C. : Cenipalma, 2010.

30 Avances tecnológicos y oportunidades de negocios para el biodiesel y la elaboración de oleoquímicos [Publicación periódica] / aut. Soragna Franceso // Palmas. - 2013. - Especial : Vol. 34. págs. 190 - 194.

31 Estado del Arte y Futuro de la industria oleoquímica de palma en el mundo [Publicación periódica] / aut. Ahmad Salmiah // Palmas. - 2007. - Especial : Vol. 28 - págs. 82-89.

32 Boletín Técnico No. 24: Tecnologías para la obtención de oleoquímicos provenientes del aceite de palmiste [Informe] / aut. Astudillo Andres [y otros]. - Bogotá D.C. : Cenipalma, 2008.

33 Introduction on Glycerol as co-product from biodiesel plants [Conferencia] / aut. Desmet Ballestra. - Bruselas (Bélgica) : Innovative uses of Glycerol from Biodiesel Plants, 2011.

34 Análisis de la refinación de glicerina obtenida como coproducto en la producción de biodiesel [Publicación periódica] / aut. Posada Duque John Alexander y Cardona Alzate Carlos Ariel // Ing. Univ. Bogotá (Colombia). - 2010. - 1 : Vol. 14. - págs. 9-28.

35 Bioprocesos aplicados a la valorización del glicerol residual en la producción de biodiesel [Publicación periódica] / Montoya Castaño Dolly y Aragón Caycedo Oscar // Palmas. - 2010 - Especial : Vol. 31 - págs.. 126-135.

36 Introduction on Glycerol as co-product from biodiesel plants [Conferencia] / aut. Desmet Ballestra. - Bruselas (Bélgica) : Innovative uses of Glycerol from Biodiesel Plants, 2011.

37 Glycerol based solvents: synthesis, properties and applications [Publicación periódica] / aut. García José I. García-Marín Héctor y Pires Elísabet // Green Chemistry. - 2010. - Vol. 12. - págs. 426-434.

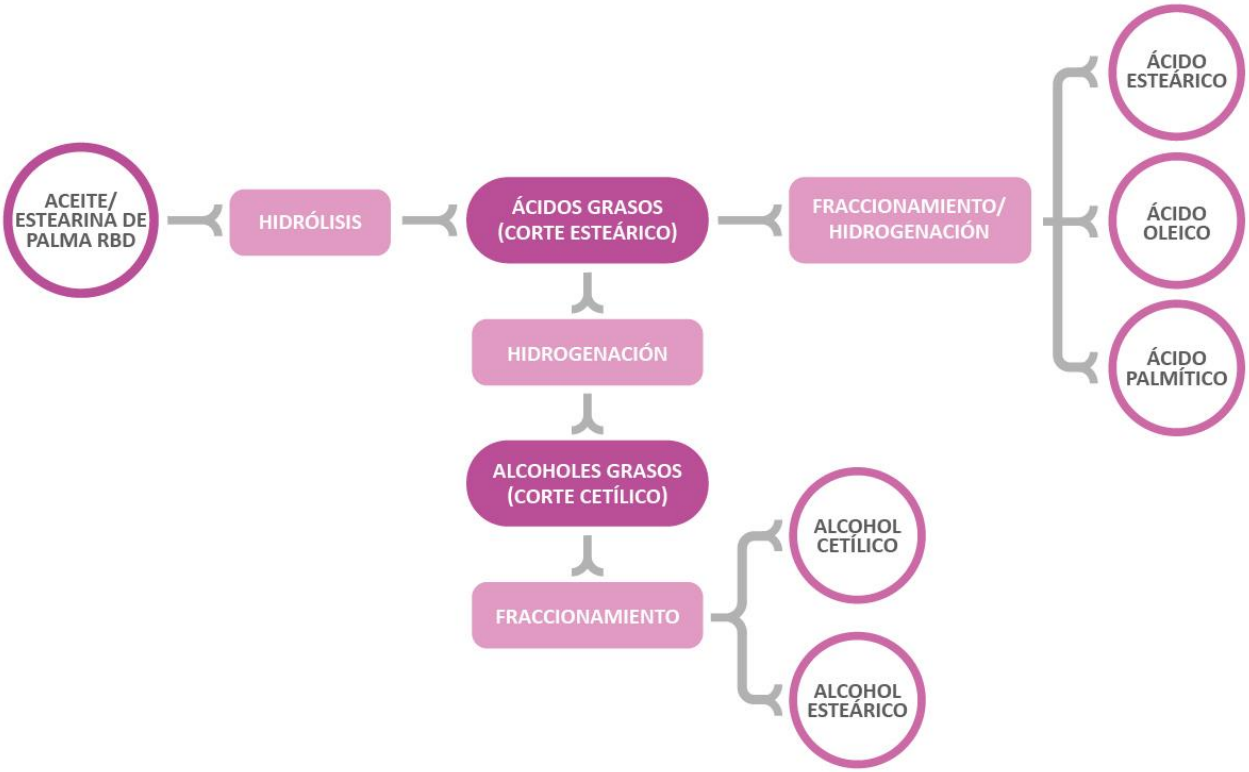
38 Utilización de aceites vegetales en la fabricación de pinturas [Publicación periódica] / aut. Nicks Peter F. // Palmas. - 1990. - 3 : Vol. 11. - págs. 21-23.

39 Principales tecnologías para la elaboración de oleoquímicos a partir de los aceites de palma y de palmiste. Segunda parte: Tecnología para la producción de oleoquímicos derivados [Publicación periódica / aut. Jaimes M. Diana I., Romero P. Carlos A. y Narváez R. Paulo C. // Palmas. - 2004 - 1 : Vol. 25. - págs. 47-66.

40 El uso del aceite de palma en la producción de poliuretanos [Publicación periódica] / aut. Cuéllar Mónica y Rivas Ana I. // Palmas. - 2004. - Especial : Vol. 25. - págs. 422-427.

the mixture can be fractioned without prior hydrogenation. Fatty alcohols can be obtained by the high pressure hydrogenation of fatty acids[41].

Figure 14. Technological Route No. 1 for obtaining oleochemicals from palm oil.

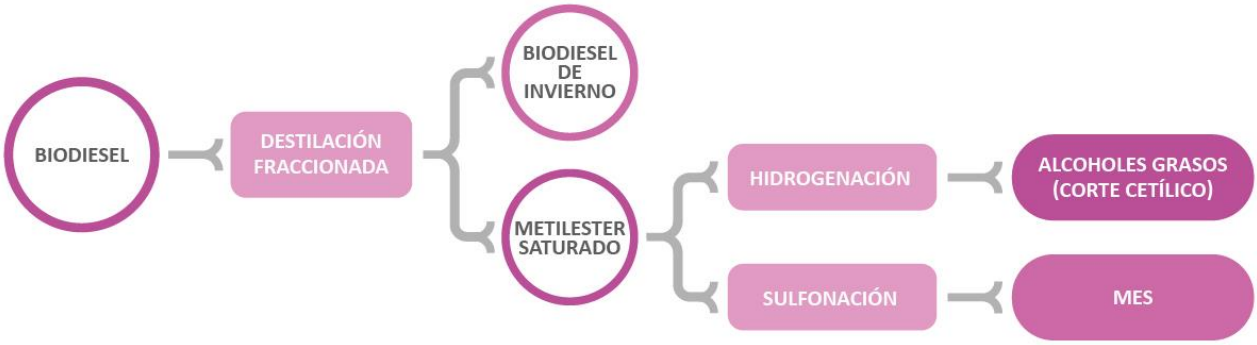


Source: self made

41 Principales tecnologías para la elaboración de oleoquímicos a partir de los aceites de palma y de palmiste. Segunda parte: Tecnología para la producción de oleoquímicos derivados [Publicación periódica / aut. Jaimes M. Diana I., Romero P. Carlos A. y Narváez R. Paulo C. // Palmas. - 2004 - 1 : Vol. 25. - págs. 47-66.

There is another route for the production of oleochemicals that makes use of the installed capacity of biodiesel plants. This is achieved by the fractional distillation of biodiesel. The saturated fraction is used to make oleochemicals, either fatty alcohols or Sulfonated Methyl Ester (MES), while the unsaturated fraction is biodiesel with excellent behavior at low temperatures[42] [43].

Figure 15. Technological Route No. 2 for obtaining oleochemicals from palm oil.



Source: self made

42 Building plants for biodiesel and co-products [Informe] / aut. Toh T.S. y Koh P.M. - Lipochem (M) Sdn Bhd.: Biofuel Plants, 2008.

43 Boletín Técnico No. 26: Metil éster sulfonado: una generación nueva de surfactantes [Informe] / auto. Rincón M. Sandra., Martínez C. Daniel M. y García N. Jesús A. - Bogotá D.C. : Cenipalma, 2010.

III.Conclusion

There are many possibilities to improve the export position of the Oil Palm Industry. When industries are competitive the suggestion is to diversify markets focusing on major global markets. On the other hand, opportunities are evidenced in domestic markets regarding industries that are highly dependent on the international market (animal feed, detergents, vitamins). Finally, it is suggested that industries innovate and diversify towards products of greater sophistication (oleochemicals and phytonutrients). Bancóldex has instruments to support entrepreneurs who wish to start their diversification process in order to reach new markets and innovate in products.

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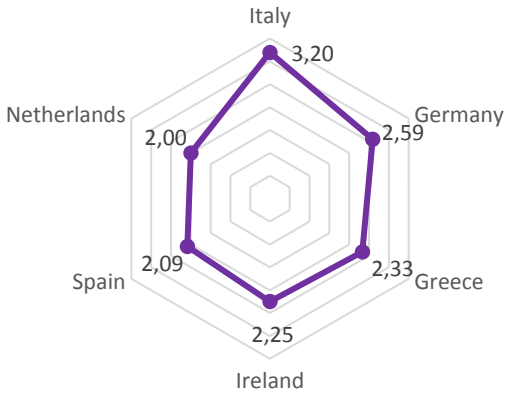
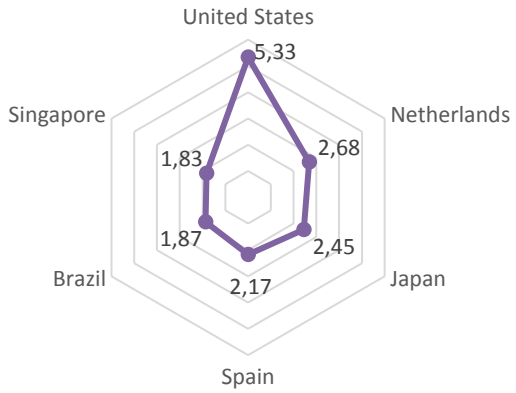
APPENDIX 1

TOP 6 countries specialized by their Revealed Comparative Advantage (RCA) in the industry's most sophisticated products

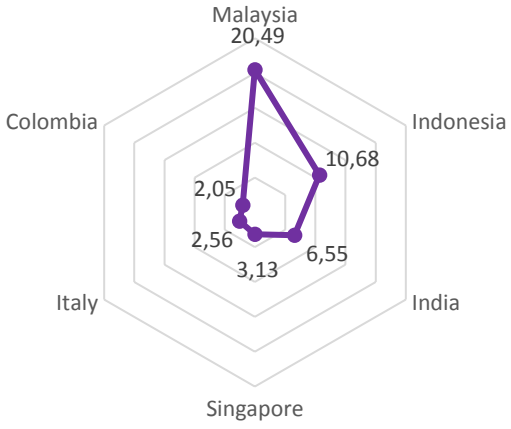
Polyurethanes (oleochemical)
Complexity index: 2.75
Revealed Comparative Advantage:



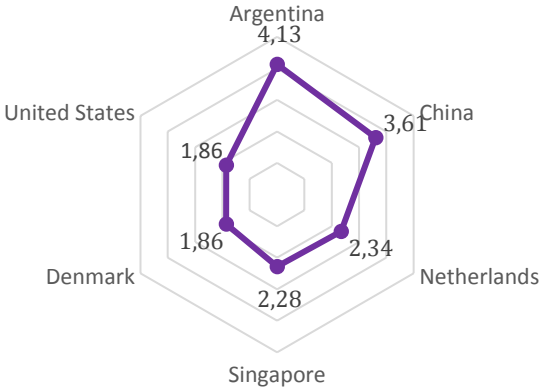
Sterols and Inositols (phytonutrient)
Complexity index: 2.71
Revealed Comparative Advantage



Palmitic and Stearic Acids (oleochemical)
Complexity index: 2.36
Revealed Comparative Advantage:



Vitamin E (phytonutrient)
Complexity index: 2.29
Revealed Comparative Advantage:



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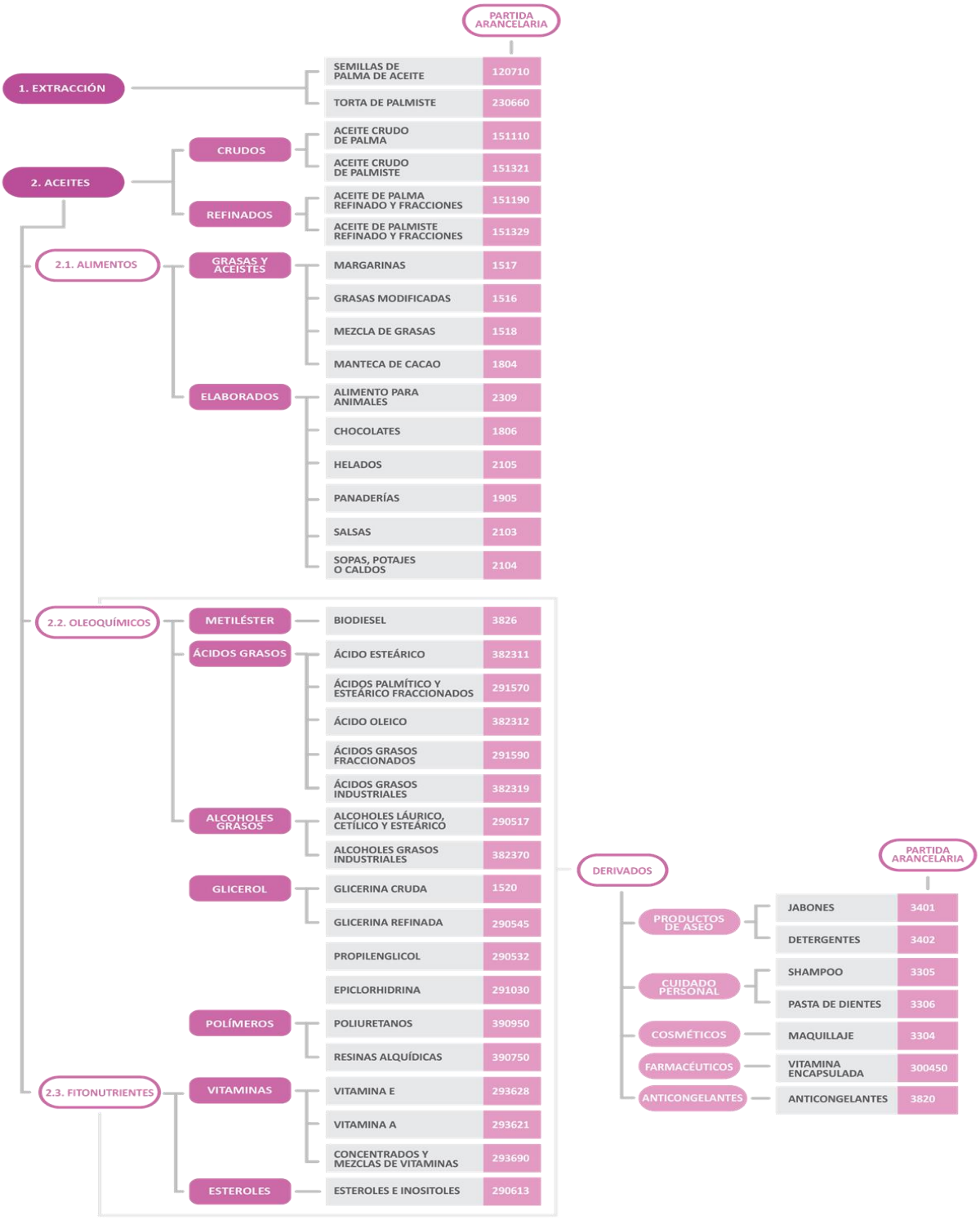
APPENDIX 2

Export Value Chain of the Oil Palm Industry



Source: self made

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