

# Emerging Business Opportunities in Castor Oil Derivatives



## Abstract

Castor oil is one of the most versatile plant oils. The various grades of the oil and its derivatives are used in over a dozen diverse industries already. In future, castor oil and castor oil oleochemicals have the potential to be used in newer industries, with the rising environmental concerns, and the increasing need for bio-based products to replace synthetic feedstocks.

This brief whitepaper published by CastorOil.in has a focus on the key oleochemical derivatives of castor oil and its emerging market applications. This article highlights the various new castor oil products that have been launched in recent years and throws light on the emerging market applications that are likely to have a significant potential in the future.

The objective of this white paper is to sensitise entrepreneurs about the promising future potential for castor oil derivatives, and to provide insights on the key growth markets for the future.

The white paper will hence be specifically useful for entrepreneurs and businesses keen on exploring new business opportunities in sustainable products, especially sustainable bio-products and biochemical.

This white paper has been published in conjunction with the latest update of the Comprehensive Castor Oil Report, the only in-depth market report worldwide for castor oil and derivatives.

More about the report from here - <http://www.castoroil.in/reference/report/report.html>

## Overview of Castor Oil Derivatives

The following table provides a comprehensive list of castor oil derivatives, classified on the basis of generation. The basic and generation I derivatives are essentially considered as commodities and incorporate small value additions, and provide thin margins (in the range of 5%). On the other hand, the value additions and profit margins for generation II & III derivatives are significantly higher than the generation I and basic grades and are very attractive.

Classification of Castor Oil Derivatives	
<b>Basic Commodity Grades</b> <ul style="list-style-type: none"> <li>❖ First Pressed Degummed Grade Castor Oil</li> <li>❖ Refined Castor Oil – Extra Pale Grade</li> <li>❖ Castor Oil Pharmaceutical (I.P./B.P./U.S.P.)</li> <li>❖ Blown Castor Oil</li> <li>❖ Urethane Modified Castor Oil</li> <li>❖ Commercial Castor Oil</li> <li>❖ Refined Castor Oil – F.S.G./B.S.S.</li> <li>❖ Refined Castor Oil – Pale Pressed Grade</li> <li>❖ Dehydrated Castor Oil (DCO)</li> <li>❖ Urethane Grade</li> </ul>	<b>Generation I derivatives</b> <ul style="list-style-type: none"> <li>❖ Sulfonated Castor Oil – Turkey Red Oil</li> <li>❖ Ethoxylated Castor Oil</li> <li>❖ Hydrogenated Castor Oil</li> </ul>
<b>Generation II derivatives</b> <ul style="list-style-type: none"> <li>❖ Sebacic Acid</li> <li>❖ 2-Heptanol</li> <li>❖ Ricinoleic Acid</li> <li>❖ 2-Octanol</li> <li>❖ Undecylenic Acid</li> <li>❖ Heptanoic Acid</li> <li>❖ 12-Hydroxy Stearic Acid (12-H.S.A.)</li> <li>❖ Undecanoic Acid-2</li> </ul>	<b>Generation III derivatives</b> <ul style="list-style-type: none"> <li>❖ Zinc Undecylenate</li> <li>❖ Undecylenic Aldehyde</li> <li>❖ Heptaldehyde</li> <li>❖ Methyl-12-Hydroxy Stearate</li> <li>❖ Methyl Ricinoleate</li> <li>❖ Methyl Undecylenate</li> <li>❖ Calcium Undecylenate</li> <li>❖ Zinc Ricinoleate</li> </ul>

## Existing Markets and Applications of the Castor Derivatives

Castor oil's application range is very wide. From the attractive uses such as cosmetics to the areas of national security involving engineering plastics, jet engine lubricants and polymers for electronics and telecommunications, castor oil plays an important role in today's industry.

The table below provides an overview of the applications in which castor oil and its derivatives are used.

<b>Agriculture</b> Organic Fertilizers	<b>Plastics and Rubber</b> Polyamide 11 (Nylon 11) ,Plastic Films, Adhesives, Coupling Agents, Polyols, Synthetic Resins, Plasticizers
<b>Food</b> Surfactants, Viscosity Reducing Additives, Flavourings, Food Packaging	<b>Cosmetics and Perfumeries</b> Perfumery Products, Lipsticks, Hair Tonics, Shampoos, Polishes, Emulsifiers, Deodorants
<b>Paper</b> Flypapers, Defoamer, Water Proofing Additive	<b>Pharmaceuticals</b> Antihelmintic, Antidandruff, Cathartic,Emollient,Emulsifiers, Deodorants
<b>Electronics and Telecommunications</b> Polymers for Electronics and Telecommunications, Polyurethanes, Insulation Materials	<b>Paints, Inks and Additives</b> Inks, Plasticizer for Coatings, Varnishes, Lacquers, Paint Strippers, Adhesive Removers, Wetting and Dispersing Additives
<b>Textile Chemicals</b> Textile Finishing Materials, Dyeing Aids, Nylon, Synthetic Fibers and Resins, Synthetic Detergents, Surfactants, Pigment Wetting Agents	<b>Lubricants</b> Hydraulic Fluids, Heavy Duty Automotive, Greases, Fuel Additives, Corrosion Inhibitors, Lubricating Grease, Aircraft Lubricants, Jet Engine Lubricants, Racing Car Lubricants

## Emerging Markets and Applications of the Key Derivatives

Applications such as bio-polymers, oil field chemicals, coatings, adhesives and lubricants are encouraging the use of castor oil and derivatives beyond their traditional use in soaps and detergents. CastorOil.in, in an attempt, to explore the emerging castor oil and its derivatives applications, performed a brief market research on the castor based products that have been launched, in the past few years. The table below provides an overview of the castor oil based products that have been introduced since 2011.

### Products Launched Using Castor Derivatives Since 2011

Company	Product Category	Applications
<b>Ford and BASF</b>	Polyurethanes	Castor oil-based foam for the instrument panel
<b>Radici Group</b>	PA 6.10	Engineering plastics for the automotive industry, Fibres for textiles
<b>The North Face</b>	Polyamides	Sportswear – Water proof breathable castor bean membrane
<b>Zeal optics</b>	Polyamides	Plant based lens
<b>Toray</b>	Polyamide fibres	Sportswear - Outdoor water-proof clothing that are both lightweight and breathable.
<b>BASF</b>	Polyamide 6.10.	Apparels, Furnishings, Automotive and Other Applications
<b>Rhodia</b>	Polyamide	Solutions for blow molding, developed specifically for fuel contact applications
<b>Solvay</b>	Polyamide 6,10	Bio-based high-performance polyamides for use in smart mobile devices such as smart phones, tablets, laptops, and other smart mobile electronics.
<b>Hipro Polymers Co.</b>	Nylon 6/10, 10/10, and 10/12	Automotive tubing systems, backsheet for photovoltaic solar modules, electronics components, as well as slewing ring parts for wind turbines.
<b>Arkema</b>	PA10.10	Monolayer or multilayer brake lines for trucks and fuel lines for cars, industrial pipes, cables, and injection molded parts for sports or electronics applications.

Worlee	Personal Care	Natural exfoliation (Hydrogenated castor oil beads) as alternatives to plastic microparticles (PE and PP)
Evonik	PA 6,10; PA 10,10; and PA10,12	Injection molding, fibers, powder, extrusion and films.
Nike	Polyamides (From Arkema's Pebax )	Light weighed shoes
Arkema	Personal Care	Hair care, deodorant, beauty creams etc (Methyl Undecylenate and Undecylenic Acid)
Aveya Beauty	Personal Care	Hair growth products
Hutchinson SRL	Polyamide 10.10	Fuel lines
Fiat	Polyamide 10. 10 (From DuPont's Zytel)	Fuel lines

Source: CastorOil.in

From the above table, CastorOil.in observes two interesting market applications of castor oil, which are growing steadily.

- ❖ **Castor Oil Polymers and**
- ❖ **Castor Oil Personal Care Products**

Castor oil is being predominantly used in the production of polyamides recently. Though the knowledge of using castor oil for producing polymers has a long history (with the use of Arkema's Rilsan PA 11), the market is now expanding as more and more companies are working on castor oil polyamide products. Automotives occupies a dominant position in the consumption of castor oil, followed by the personal care industry.

## Castor Oil - A Useful Raw Material for Specialty Nylons and Polyurethanes

Castor oil has long been a non-food-crop source of biopolymers for fibres and plastics, specifically Arkema's Rilsan (PA 11). The options are now expanding as more and more companies are working on castor oil polyamide products.

Sebacic acid, a key castor oil derivative is used in the production of nylons.

Many major nylon producers have introduced castor-oil based long-chain nylons into their overall portfolio because of their unique properties and sustainability appeal. *"The demand for bio-based raw materials is increasing worldwide", says Hermann Althoff, Senior Vice President of the Global Polyamide and Intermediates Business Unit at BASF.* In Europe, PA 6,10 is becoming a popular bio-based polyamide. Producers of PA 6,10 include **Arkema, Evonik, BASF, EMS-Chemie, DuPont and Solvay.**

*Lux Research* points out automotives as a large potential market for bioplastics. The firm says that about 12 percent of the mass of a vehicle is made up of polymers.

Potential applications in the automotive industry include fuel lines, hydraulic hoses, corrugated tubes, transmission oil cooler hoses, pneumatic tubes, coolant and degassing pipes, servo brakes, clutch tubes, radiator end tanks, filaments, oil and gas transportation, connectors, sensors and solenoids, hand held devices, sporting goods, industrial tubes and hydraulic applications.

Automakers such as **Daimler, Fiat and Ford** have been turning to castor oil derivatives to cut the petrochemical content of their vehicles and increase their use of renewable or recycled materials. The companies say the foam is more durable than its predecessors, with better tear strength and reduced elongation. Fiat used castor oil-derived long chain polyamides to replace their fossil based equivalent in more than one million vehicles; the company plans to further increase this number.

*The use of biobased materials in the automotive industry, although still in its infancy, has been gradually accelerating over the last few years.*

## Emerging Applications of Castor Biopolymers

The following table provides an overview of the emerging and existing applications of castor biopolymers

Castor Oil Biopolymers	
Existing Application Areas	Emerging Application Areas
<b>Mobility</b> - Tubing, Airbraking, Liners <b>Solar</b> - Backpanels, Barrier Sheets <b>Household</b> - Powder Coating <b>Cables</b> - Jacketing	<b>Filaments</b> - Tooth brushes, Carpets and Tires <b>Sports</b> - Shoe Soles, Outdoor Apparel <b>Cosmetics</b> - Fine powders <b>Electronics</b> - Casings

**Sports Wear:** As folks in the polyurethane industry would tell you, the sports products and footwear markets are other hot spots for bioplastics.

- Nike has launched a boot sole plate made of 50% Pebax Renew (Arkema's castor-based thermoplastic elastomer with about 97% renewable-based component), and 50% bio-based thermoplastic polyurethanes (TPU).
- In 2011, North Face, an American outdoor product company, introduced a water proof breathable castor bean membrane in one of its jackets

### **Electronics:**

- DuPont™ Zytel® RS HTN, a high-performance castor oil-based polyamide, has seen a four times growth rate since its introduction four years ago especially in the application of hand-held electronics.
- Solvay recently launched a new portfolio of bio-based high-performance polyamides offered for use in smart mobile devices such as smart phones, tablets, laptops, and other smart mobile electronics.

### **Cosmetics:**

In personal care, polyamide based particles like Nylon 12 powders are commonly used to enhance the haptic properties of cosmetic formulations. They generally act as mattifying agents in order to reduce the shine on human skin. Due to their porosity, these particles are also used to reduce the stickiness and oiliness of cosmetic products during application. Moreover, they can act as binders in pressed powder and other types of color formulations.

- In August 2013, Worlee Cosmetics of Germany has developed castor oil based beads from Hydrogenated Castor Oil (HCO), which can be used as a cosmetic rinse-off product, replacing PE and PP plastic micro particles as an exfoliant.



## Prominent Ventures and Partnerships

2013	2012
<ul style="list-style-type: none"> <li>❖ In April 2013, Arkema announced the acquisition of a 25% stake in Jayant's castor oil producing subsidiary to secure oil for making nylon 10, 10 and 11.</li> </ul> <p><b><i>It was its increasing consumption of castor oil that led Arkema to link up with Jayant, according to Lionel Guerdoux, managing director of Arkema's speciality nylons business.</i></b></p> <ul style="list-style-type: none"> <li>❖ In May 2013, DSM India Pvt Ltd, a subsidiary of Royal DSM, signed a Memorandum of Understanding (MoU) with the India based Electrical Research &amp; Development Association (ERDA), covering basic research in the field of electrical applications.</li> <li>❖ In August 2013, the Japanese firms Mitsui Chemicals and Itoh Oil Chemicals announced a joint venture with Jayant Agro - Organics, an Indian castor oil refiner, to produce castor oil derived chemicals for the auto industry. Mitsui claims the venture will make castor oil derived polyols competitive with petrochemical ones.</li> <li>❖ In October 2013, Arkema entered into a partnership with Addiplast, to supply its polyamides 10, 11 and 12, which will be processed into technical compounds and materials. These high added value solutions is said to be targeting high performance applications, in particular in the automotive and electronics sectors.</li> <li>❖ Solvay is said to be building a facility in Lyon, France, to produce nylon 6, 10.</li> </ul>	<ul style="list-style-type: none"> <li>❖ Arkema, in 2012, acquired the Chinese companies Casda, a company involved in sebacic acid derived from castor oil, and Hipro Polymers, which produces polyamides also from castor oil (Hiprolon® PA6.10, PA6.12, PA10.10, PA10.12)</li> </ul> <p><b>2011</b></p> <ul style="list-style-type: none"> <li>❖ In 2011, Ford and BASF teamed up to develop a castor oil-based foam product for the 2012 Ford Focus instrument panel</li> <li>❖ Fluid transfer system supplier Hutchinson SRL (Rivoli, Italy) used Dupont's Zytel RS polyamide grade PA1010 derived partly from castor oil for the production of fuel lines used with both diesel and biodiesel.</li> <li>❖ Solvay has been working with Mitsubishi Gas Chemical since 2010 on developing high-temperature castor oil-based polyamides for high-performance durable applications.</li> </ul> <p><b><i>These developments are harbingers of growth for the castor oil industry, according to Robert Kolb, who now runs Latina, a New York City based firm that imports the oil and its derivatives.</i></b></p>

## Castor Biopolymers - Market

### Key Points

- Durable bioplastics – including bio-based commodities such as PE, PP, PET AND PVC as well as high performance PA polymers – are expected to account for close to 60% of its predicted global bioplastics production capacity of **1,700,000 tonnes in 2015**.
- Specialty bio sourced polyamides have a growth rate of 15 per cent per year.
- Export values of sebacic acid and derivatives from China between January and March 2013 were estimated at a range of **\$3500/ton to \$5000/ton**.
- Prices for PA 6,6 engineering resins in China are at around \$2800/ton cfr China, currently. Prices for PA 10,10 are said to be at least twice the price of PA 6,6 but details are not available at this point.
- **Automotives industry and bioplastics**– The consumption of bioplastics in the automotive segment which is estimated at just **75 million tons** of bioplastics in 2013 is expected to increase at 10 fold in 2018
- **Biopolyamide drivers** - The global market for bio-based polyamides is experiencing strong growth rate (about 15% per year) supported by the need of technology, the cost reduction, the environmental policies, and the emerging countries
- **Sebacic acid demand**
  - More than 70% of global sebacic acid demand is for polyamide 10,10 and 6.10, according to an industry source. In 2010, global demand for sebacic acid was 58,700 tonnes and more than 90% are produced in China.
  - According to industry sources, Chinese sebacic acid producers have incurred huge losses due to sustained fall in sebacic acid export price from \$5,200 a tonne in May 2011 to \$3,800 a tonne in November 2012. Analysts say the reason for this reduced demand is the weakened economic situation in Europe and US.

*"There is a tremendous growth opportunity for castor-based chemicals, but companies interested must commit to research and development," says Larry Slovin who was previously president of the performance materials business of US specialty chemical company Vertellus.*

## Castor Oil for Cosmetics

Another emerging application of castor oil lies in the cosmetics industry. Though it can be said, the consumption is not higher as that of the polymers; the use of castor oil in this industry is increasing steadily.

Castor oil has been used in skin care products for centuries, and continues to play an important part in the production of soaps and cosmetics. *Ricinus Communis* (Castor) seed oil is the naming convention for castor oil used in cosmetics. Ricinoleic Acid, along with certain of its salts and esters function primarily as skin-conditioning agents, emulsion stabilizers, and surfactants in cosmetics, although other functions are described. Provided below is the sample list of companies which use castor oil and its derivatives in their product formulations.

Company	Castor Ingredient	End Use
Lavilin,, US	RicinusCommunis (Castor) Seed Oil & Hydrogenated Castor Oil	Deodorant Cream
Jason, US	Zinc Ricinoleate	Hand and body lotion and deodorants
Avene, US	Zinc Ricinoleate	Deodorant production
Eckart (A Company of Altana), Germany		Lip sticks
Lavera, USA	Zinc Ricinoleate and Hydrogenated Castor Oil	Deodorant , Body lotions, Sunscreen lotions
Arkema, France*	Undecylenic Acid	Hair care, deodorant, beauty creams etc
Aveya Beauty*	Black castor oil	Hair growth products
Worlee Cosmetics*	Hydrogenated castor oil	Natural exfoliants as alternatives to plastic microparticles (PE and PP)

\*: These were launched post 2011

Castor Products & Derivatives That Can Be Used In The Cosmetics Industry
<ul style="list-style-type: none"> <li>• Castor Oil</li> <li>• Castor Oil Esters</li> <li>• Undecylenic Acid</li> <li>• Castor Wax</li> <li>• Zinc Ricinoleate</li> <li>• Heptaldehyde</li> <li>• Heptanoic Acid</li> <li>• Undecylenic Acid</li> <li>• Heptyl Alcohol</li> <li>• Ethyl Heptoate</li> <li>• Heptyl Acetate</li> </ul>

## Natural Cosmetics Market

Natural cosmetics have driven innovation and growth in the worldwide cosmetics sector for years. As consumers become more concerned about personal care and the ingredients that are found in cosmetics, the natural and organic cosmetics market has seen solid growth in the recent years.

Experts estimate the market of global natural cosmetics sector at \$9 billion. Market research firm Euromonitor, London forecasts that the worldwide market for organic and natural cosmetics will grow by an average of 5% per year until 2015.

**With the overall market for cosmetics and personal care products in the United States alone expected to reach a value of \$19.2 billion by 2015, one can say that there is a bright future for castor oil based derivatives in this industry.**

## Summary

Demand for more renewable and bio-based solutions is increasing with rise in population and consumption growth, climate change and energy & resource security. To meet this requirement, companies will have to look after investment in sustainable and bio-based products and production processes. This is expected to drive the bio-based PA industry to next level, as well.

Our brief research on the recent trends in new applications for castor oil derivatives suggest that there has been a significant amount of interest worldwide in the use of castor oil for production of polyamides and other polymers such as polyurethane; this is likely to result in significant demand increases for oleochemicals such as sebacic acid, undecylenic acid and special grades of castor oil.

Meanwhile, the increasing demand for organic and natural cosmetic products is also creating new growth opportunities in the castor oil market, thus encouraging the emergence of new market players.

## **About CastorOil.in**

CastorOil.in ([www.castoroil.in](http://www.castoroil.in)) is the leading global intelligence and information resource for the castor oil and castor derivatives industry. In addition to providing comprehensive information assistance online, CastorOil.in publishes the Comprehensive Castor Oil Report, a report on castor oil, providing essential inputs for businesses, entrepreneurs and investors interested in exploring the castor industry.

## **Comprehensive Castor Oil Report** [www.castoroil.in/reference/report/report.html](http://www.castoroil.in/reference/report/report.html)

Those interested in knowing more about the castor oil and derivatives industry will find the Comprehensive Castor Oil Report an indispensable guide. This report provides comprehensive details on all the segments of the castor industry value chain - from cultivation of castor crop to production of high end derivatives. It contains critical investment and production process intelligence relevant to investors and businesses, and has a detailed section on the production of second and third generation derivatives from castor oil.