

# Castor Master

*Get to know emerging business opportunities for  
castor crop, oil and derivatives*



## Abstract

Castor oil is possibly the plant oil industry's most underappreciated asset. It is one of the most versatile of plant oils, being used in over ten diverse industries. Owing to its unique chemical structure, castor oil can be used as the starting material for producing a wide range of end-products. The plant itself requires relatively less fertilizers, pesticides, water and maintenance than most other cultivated crops, and it can grow in marginal land. With so many unique advantages, one would expect the castor crop to be widely grown world over. Strangely, it is not so.

This is all set to change, as many companies, entrepreneurs and governments are waking up to the potential of the castor crop, castor oil and castor oil derivatives. In the past few years alone, a number of countries which have little or no land under castor cultivation have started making serious exploratory efforts at growing castor. A number of companies are doing cutting edge research on the use of castor to produce bioplastics and biopolymers such as polyurethane, nylon and more. With the increasing use of biolubricants and bio-greases, castor oil is emerging as the preferred feedstock choice, owing to the already prevalent applications of castor oil derivatives for these purposes.

Essentially, this document is divided into two parts. The first part contains a brief whitepaper published by Castoroil.in which has a focus on key oleochemical derivatives of castor oil and its emerging market applications. The objective of this 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 second part of the document contains the sample of the Comprehensive Castor Oil Report which provides relevant and critical information on castor oil and its derivatives. This report presents the current and future potential of the castor oil industry.

## Part 1

# Emerging Business Opportunities in Castor Oil Derivatives

## 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> Anthelmintic, 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

<p><b>2013</b></p> <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>	<p><b>2012</b></p> <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 (Hiproton® 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>
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## 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	Castor Products & Derivatives That Can Be Used In The Cosmetics Industry
Lavilin,, US	RicinusCommunis (Castor) Seed Oil & Hydrogenated Castor Oil	Deodorant Cream	<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>
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

## 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.



## Part 2

# Preview of Comprehensive Castor Oil Report

## The Comprehensive Castor Oil Report

The Comprehensive Castor Oil Report is the most detailed report dealing with all aspects of the castor oil industry. The report focuses on providing detailed insights on the following aspects:

<i>Production</i>	<ul style="list-style-type: none"> <li>• detailed inputs on the technology and processes for producing all major castor oil derivatives</li> </ul>
<i>Market segments</i>	<ul style="list-style-type: none"> <li>• inputs on the key end-user market segments</li> </ul>
<i>Cultivation</i>	<ul style="list-style-type: none"> <li>• extensive details on the critical aspects of castor crop cultivation</li> </ul>
<i>Companies</i>	<ul style="list-style-type: none"> <li>• profiles and details on the leading companies in this industry</li> </ul>

The objective of the Comprehensive Castor Oil Report is to facilitate tangible steps for a castor oil venture. The emphasis hence is on providing practical data, updates and insights.

The report has been developed with over three years of in-depth research, and has been developed with inputs from castor oil industry experts, chemical engineering researchers, and professionals who have been constantly interacting with the castor oil industry for over a decade.

The Comprehensive Castor Oil Report will be an invaluable guide to those keen on venturing into an industry with exciting future potential. The report was last updated in January, 2014.

The chapter wise preview of the Comprehensive Castor Oil Report is given below:

# Chapter 1 – Castor Oil Manufacturing

The production process for the basic grades of castor oil are well known and well established. There are however a number of innovative processes and emerging technologies for the production of value added castor oil chemicals and derivatives. This chapter provides detailed inputs on the production processes of castor oil, its basic grades and for a diverse range of castor oil based derivatives and chemicals.

## Key Sections

### 1.1 Key Manufacturing Processes for Castor Oil & Derivatives

#### 1.1.1 Castor Oil Manufacturing Processes – Summary

- Castor Oil Extraction – Summary
- Castor Oil Filtration & Purification - Summary
- Castor Oil Refining - Summary
- Production of Castor Oil Grades & Derivative Chemicals - Summary

#### 1.1.2 Castor Oil & Derivatives Manufacturing Processes – Details

##### 1.1.2.1 Castor Oil Extraction – Details

- Pre-extraction – Seed Cleaning & Preparation
  - Seed Cleaning
  - Drying, Heating & Conditioning
  - Shelling / Dehulling & Winnowing
  - Milling & Grinding
- Oil Extraction
  - Oil Yield from Different Oil Seeds
- Pressing / Expelling
  - Expellers - Old Method
  - Expellers - New Methods
  - Manual Presses
  - Motor Driven Expellers
- Large Scale Oil Expellers
  - Single Chamber & Double Chamber Oil Expellers
  - Double Chamber Design Oil Expeller
  - Typical Features of Presses / Oil Expellers

- Special Facilities in News Expellers
- Solvent Extraction

#### 1.1.2.2 Castor Oil Filtration – Details

- Filtration
  - Filter Press
  - Plate Filter Presses
  - Features of Filter Presses
- Clarification
- Sedimentation
- Centrifugation

#### 1.1.2.3 Castor Oil Refining – Details

- The Refining Process
  - Degumming
  - Neutralization
  - De-waxing
  - Bleaching & Deodourizing

#### 1.1.2.4 Typical Sections & Sub-sections of Castor Oil Refinery Plants

#### 1.1.2.5 Castor Oil Grades & Derivatives Production

- Details of Manufacture for Specific Castor Oil Grades & Derivatives
- Process flow in Production of Undecylenic Acid & Heptaldehyde from Castor Oil

### 1.2 Indicative Costs for Setting up Small and Medium Scale Castor Oil & Derivatives Manufacturing Plants

**Details of manufacturing the following castor oil grades & derivatives are also explained in this chapter**

- Industrial / Commercial Castor Oil
- First Special Grade Castor Oil
- Cold Pressed Castor Oil
- Pale Pressed Castor Oil
- Pharma Grade Castor Oil
- Hydrogenated Castor Oil
- Sulfonated Castor Oil
- Blown Castor Oil
- Ricinoleic Acid
- 12-HSA
- Methyl 12-HSA
- Sebacic Acid
- Undecylenic Acid
- Methyl Ricinoleate
- Methyl Undecylenate
- 2-Octanol
- Heptaldehyde, Heptanoic Acid & Heptyl Alcohol

**Costs for Setting up small and medium scale castor oil & derivatives manufacturing plants are provided in this chapter.**

## **Production Process for Dehydrated Castor Oil**

### **Dehydrated Castor Oil**

Castor oil has only one double bond in each fatty acid chain and so is classified as non-drying oil. However, it can be dehydrated to give semi-drying or drying oil which is used extensively in paints and varnishes. Being a polyhydroxy compound, its hydroxyl functionality can be reduced through dehydration or increased by inter-esterification with a polyhydric alcohol. It must be noted that coatings that incorporate castor oil alone will never achieve complete cure through oxidative cross-linking as do coatings that contain oil with multiple double bonds in their fatty acid components. For this reason, dehydrated castor oil assumes special significance. The dehydration process is carried out at about 250°C in the presence of catalysts (e.g., concentrated sulphuric acid, activated earth) and under an inert atmosphere or vacuum. Under this condition of dehydration, the hydroxyl group and adjacent hydrogen atom from the C-11 or C-13 position of the ricinoleic acid portion of the molecule is removed as water. This yields a mixture of two acids, each containing two double bonds but in one case, they are conjugated. The presence of an acid containing conjugated double bonds results in an oil resembling tung oil in some of its properties. Thus, castor oil, which is non-drying, can be treated and converted into a semi-drying or drying oil known as dehydrated castor oil.



## Oil Yield from Different Oil seeds

*Typical oil yields from 100 Kg. of oil seeds*

Oil Seed	Yield
Castorseed	43 kg
Sunflower	32 kg
Copra	62 kg
Cottonseed	16 kg
Linseed	42 kg
Mustard	35 kg
Soybean	14 kg
Groundnut kernel	42 kg
Rapeseed	37 kg
Palmfruit	20 kg
Palm kernel	36 kg
Sesame	50 kg

## Key Derivatives of Castor Oil and Starting Products

Product Name	Starting Product
Commercial Castor Oil	Castor Seed
First pressed Degummed Grade Castor Oil	Commercial Castor Oil
Refined Castor Oil (F.S.G./B.S.S.)	Commercial Castor Oil
Refined Castor Oil (Extra Pale Grade)	Commercial Castor Oil
Refined Castor Oil (Pale Pressed Grade)	Commercial Castor Oil
Neutralized Castor Oil	Commercial Castor Oil
Refined Castor Oil (DAB-10)	Commercial Castor Oil
Castor Oil Pharmaceutical (I.P./B.P./U.S.P.)	Commercial Castor Oil
Turkey Red Oil	Commercial Castor Oil
Blown Castor Oil (10 to 250 Poise)	Refined Castor Oil (F.S.G./B.S.S.)
Ricinoleic Acid	Refined Castor Oil (F.S.G./B.S.S.)
Methyl Ricinoleate	Refined Castor Oil (F.S.G./B.S.S.)
Hydrogenated Castor Oil (Flakes/Powder/Granules)	Refined Castor Oil (F.S.G./B.S.S.)
12-Hydroxy Stearic Acid (12-H.S.A.) (Flakes/Powder/Granules)	Hydrogenated Castor Oil Liquid
Methyl-12-Hydroxy Stearate (Flakes)	Methyl Ricinoleate
Urethane Modified Castor Oil (UMCO)	Refined Castor Oil (F.S.G./B.S.S.)
Glyceryl-Tri-(12-Acetyl Ricinoleate)	Refined Castor Oil (F.S.G./B.S.S.)
Dehydrated Castor Oil (Commercial)	Commercial Castor Oil

## Chapter 2 – Castor Oil Market

The end user market for castor oil and castor oil derivatives is already quite diverse. With new applications of castor oil being explored, especially in areas such as pharmaceuticals and biopolymers / bioplastics, these end user markets for castor oil and its derivatives are expected to expand significantly over the next few years. This chapter provides insights into the characteristics and dynamics of the castor oil, chemicals and derivatives markets, supported by rich data and analysis. A detailed demand-supply analysis of the key castor oil chemicals and derivatives is also provided.

### Key Sections

#### 2.1 Value Chain for the Castor Industry

#### 2.2 The Castor Oil Market

- Characteristics of Castor Seed and Oil Market
- Market Influencing Factors in Castor Trade

#### 2.3 Supply & Demand of Castor Oil

- Castor Oil Production **(in '000 T) –2005 to Dec 2012**
- Castor Oil Imports **(‘000 T) – Jan 2005 to Dec 2009**
- Castor Oil Exports **(‘000 T) - Jan 2005 to Dec 2009**
- Summary of Production, Imports and Exports from Prominent Countries/Regions 2011 data (in '000 Tons)
- Castor seed - World Area, Production and Productivity – 2010-11
- India Castor Seed Area, Production and Yield
- Country-wise production of castor seed in the world
- The US Supply Scenario
- Castor Oil Production from Minor Producing Countries

#### 2.4 Indian Castor Oil Industry

##### 2.4.1 Castor Oil Exports - Historical Scenario (2000 – 2007)

##### 2.4.2 Castor Oil Exports - Current Scenario (1998-2012)

### 2.4.3 Castor Seed Production & Acreage in India

- Castor Growing Areas in India & its Production
- Major Trading Centers of Castor in India

### 2.4.4 India-wide Data from Castor Crop Survey 2009-12

### 2.4.5 Cropping Season in India

### 2.4.6 Castor Cultivation & Yields in India – Points

### 2.4.7 India's Status in the Global Castor Oil Industry

- SWOT Analysis of Indian Castor Oil Industries in Production of Chemical Derivatives

## 2.5 Demand-Supply Estimates for Castor Oil Derivatives

### 2.5.1 Current Demand-supply Estimates for the Various Grades of Castor Oil and Derivatives

### 2.5.2 Future Demand-supply Estimates for the Various Grades of Castor Oil and Derivatives

- Growth of Key End-User Segments
- Growth Prospects for Bio-based Products
- Demand-Supply Estimates

## Supply & Demand of Castor Oil

*Castor Oil Production (in '000 T)*

Countries	2011-12(F)	2010-11	2009	2008	2007	2006	2005
Brazil	63.45	45.45	42.5	52.3	43.3	48.7	70.2
China,PR	81	81	81.4	83.1	81.5	90.2	101.7
India	675	540	375.8	413.0	367.6	351.2	335.2
Thailand	5.4	5.4	5.4	5.7	5.6	5	4.5
African countries	7.2	7.2	24.4	23.8	22.5	21.9	21.2
<b>Total</b>	<b>832.05</b>	<b>679.05</b>	<b>531.8</b>	<b>580.3</b>	<b>522.6</b>	<b>518.5</b>	<b>534.3</b>

Source – CastorOil.in and derived from data obtained from sources such as Oilworld - [www.oilworld.biz](http://www.oilworld.biz)

## **Future demand-supply estimates for the various grades of castor oil and derivatives**

### *Growth of Key End-User Segments*

The major end-use industries for castor oil derivatives castor oil are:

- Lubricants & Greases
- Coatings
- Personal Care & Detergent
- Surfactants
- Oleochemicals

### *Growth of Key End-user Industry Segments for Castor Oil Derivatives*

<b>Industry</b>	<b>% Growth (CAGR), based on 2005 data</b>	<b>Potential</b>
Lubricants & Greases	2	44 million T by 2012
Coatings	4.9% (about 11% in Asia!)	-
Personal Care & Detergent	6%	\$375 billion by 2012
Surfactants	4%	\$16.65 billion by 2012
Oleochemicals	4%	8.5 million T by 2012

***Detailed information on castor oil market, castor oil production worldwide and current and future demand- supply estimates of castor oil and its derivatives are provided in this chapter. The chapter also talks in detail about the castor industry in India.***

*India Export of Castor Oil (Excluding Derivatives)*

Year	Volume (MT)	Value (Rs Crore )	Value per T (Rs / T)
1998-99	193,913	595.98	30734
99-00	234,824	897.56	38223
00-01	227,033	806.07	35505
01-02	204,877	556.22	27149
02-03	163,862	520.85	31786
03-04	161,619	603.27	37327
04-05	208,176	788.56	37879
05-06	182,159	627.43	34444
06-07	195,610	653.05	34995
07-08	176,177	757.29	42985
08-09	308,625	1821.57	59022
09-10	345,333	1780.31	54271
10-11	343,254	2362.46	105288
11-12	404,489	3804.78	73,500
12-13	279,195	2036.85	80,000
(Upto October, 2012)			



### Country-wise production of castor seed in the world

Country	Area ('000 ha)	Production (000' t)	Yield (kg/ha)
Angola	13.5	3.5	259
Brazil	156.4	120.5	770
China PR	225.0	220.0	978
Ethiopia	6.8	7.0	1029
Haiti	2.9	1.6	552
India	880	1123.0	1276
Indonesia	6.0	1.0	167
World	1524.7	1580.6	1037.0

## Chapter 3 – Castor Oil Chemicals and Derivatives

Castor oil derives its unique properties from its distinct chemical structure. Many of the valuable derivatives of castor oil also owe their advantages to this unique structure. Data on the chemical structure and composition of the derivative are crucial to determine its suitability for specific applications and end uses. This chapter provides detailed inputs on the chemical structures, compositions and properties of castor oil, its various grades, and the diverse chemicals and derivatives.

### 3.1 Introduction

- Castor Plant Chemistry
- Summary List of Key Derivatives of Castor Oil

### 3.2 Properties & Chemical Composition of Castor Oil

- Castor Oil Chemistry and Composition
- Castor Oil Composition vs. Composition of Other Vegetable Oils
- Properties

### 3.3 Chemical, Physical Properties & Specifications of Castor Oil Grades & Derivatives

#### Chemical, Physical Properties & Specifications of Castor Oil Grades & Derivatives

##### Commercial Grade Castor Oil

Appearance	Pale Dark Yellow
Colour in 1" Cell, Y+5R Lovibond	30 units max.
Iodine Value	82 – 90
Saponification Value	177 – 187
Hydroxyl Value	160 min.
Acid Value	2.0 max.
Moisture & Volatiles	0.50% max.
Specific Gravity @ 20o C	0.954 – 0.967

### Castor Seed Acreage and Production in India

Year	Area ('000 ha)	Production ('000 tonnes)	Yield (kg/ha)
1985-86	637	308	480
1990-91	810	716	880
1995-96	880	930	1060
1996-97	776	770	990
1997-98	810	800	990
1998-99	835	840	1070
1999-00	782	765	979
2000-01	1080	883	818
2001-02	716	652	911
2002-03	583	428	733
2003-04	712	796	1111
2004-05	743	793	1068
2005-06	864	990	1146
2006-07	628	762	1213
2007-08	786	1053	1339
2008-09	840	1114	1326
2009-10	814	984	1209
2010-11	859	1190	1385
2011-12	1278	1620	1417

Source: Ministry of Agriculture, GOI and [castoroil.in](http://castoroil.in)

<b>BP Grade Castor Oil</b>	
CAS No	8001-79-4
EINECS	292-293-8
Colour	Nearly Colourless or Faintly Yellow
Relative Density at 20°C	0.952-0.965
Moisture	0.3% max.
Iodine Value	82-90
Saponification Value	176-187
Acid Value	2.0 max.
Unsaponifiables w/w	0.8% max.
Optical Rotation	between +3.5° and 6.0°
Hydroxyl Value	150 min.
Peroxide Value	5.0 max
Light Absorption	1.0 max

**Detailed insights on unique properties of castor oil and its derivatives are provided in this chapter.**

## Chapter 4 – Castor Oil Prices

Castor oil and castor seeds are known for the volatility in their prices. Castor crop cultivators, castor oil derivatives producers, and consumers have a critical need to factor in this price volatility in their business modeling and planning. This chapter provides detailed inputs on the historical prices and price variations of castor seeds and castor oil, and also an analysis of factors that are responsible for this volatility.

### Key Sections

#### 4.1 Historical & Current Price Data for Castor Oil, Castor Seeds

- Castor Seed Prices
- Castor Oil Prices
- A Snapshot of Castor Seed, Castor Oil & Castor Cake Prices in Jul/Aug 2011 and Jan 2012

#### 4.2 Castor Oil and Castor Seed Price Volatility

- Pricing Pattern
- Rationale for the Castor Seed Contract
- Importance of Castor Seed and Castor Oil Futures

#### 4.3 Factors that Affect Prices

- Characteristics of Castor Seed and Oil Market
- Market Influencing Factors in Castor Trade

#### 4.4 Castor Oil Futures Market

### Historical & Current Price Data for Various Grades of Castor Oil, Castor Seeds

*Castor Oil Prices (average price for commercial grade) – US\$/T, FOB Mumbai*

Year	2003	2004	2005	2006	2007	2008 (Feb)	2008 (Jun)	2009 (Jan)	2009 (Jun)	2010 (Jan)	2011
Price	925	850	925	775	1025	1160	1350	1050	1104	1330	1832

### A Snapshot of Castor Seed, Castor Oil & Castor Cake Prices in Jul/Aug 2011 and Jan 2012

All castor products hit a record high in Jul/Aug 2011. A look at the average prices below will tell the story.

Product	Price
Castor Seed	1092
Castor Oil	2100
Castor Cake	110

The data for average prices in Jan 2012 tell an entirely different story.

*All prices in US \$ / Metric Ton, FOB India*

Product	Price
Castor Seed	736
Castor Oil	1550
Castor Cake	109

### Rationale for the Castor Seed Contract

There is significant fluctuation in the production of castor seeds in India. The market participants like the farmers, traders, oil millers, exporters and industries which produce value added derivatives face an eternal price risk due to fluctuating production. Hence it is imperative to introduce a hedging mechanism for efficient price discovery and price dissemination.



## Chapter 5 – Castor Cultivation

Compared to many other crops, castor crop requires relatively fewer inputs such as water, fertilizers and pesticides. The crop can also be grown on marginal land, thus providing an excellent opportunity for many regions of the world to utilize their land resources more productively. At the same time, following proper procedures during sowing and maintenance will result in much high crop yields than otherwise. In addition, use of high-yield hybrid varieties also can have a positive effect on crop and seed yields. This chapter provides critical inputs on all aspects of castor crop cultivation, maintenance and harvesting, with an emphasis on the key success factors that will result in high yields.

### Key Sections

#### 5.1 Introduction

#### 5.2 Castor Crop Sowing

- Soil
- Land Preparation
- Sowing

#### 5.3 Castor Crop Growth

- Fertilizers
- Water
  - Rainfall
  - Irrigation
- Climate
- Crop Protection
  - Pests that are Harmful to Castor Plant
  - Weed Control
  - Renumerative intercropping systems with castor
  - Recommended crop sequences and rotations for castor

#### 5.4 Castor Crop Harvest

## 5.5 Castor Cultivation Seasons

## 5.6 Hybrid Castor Seeds & Genetic Engineering of Castor Plant

- Castor Varieties Recommended in India - Statewise
- Castor Varieties in Gujarat
- Development of Pistillate Lines
- Development of Promising Inbred Lines and Hybrids<sup>1</sup>
- International Germplasm Center

## 5.7 Yields for Castor Seeds and Castor Oil from Seed

- Castor Seed Yield
- FAO Data for castor seed yields
- Castor Oil Yield

## 5.9 Impact of agronomic practices on productivity of castor seeds

## 5.8 Castor Cultivation FAQ

## Castor Seed Varieties & Hybrids

*Some Short Term (annual) Varieties Tested in East Africa*

Variety	Time To Maturity
II23	7-10 Months
UC53	7-10 Months
Baker 44	5-7 Months
Baker 22	5-7 Months
Lynn	5-7 Months

*Advantages of annual varieties:* Higher yield potential, seeds seldom shatter and have uniform hull strength and thickness.

*Disadvantages of annual varieties:* Pest susceptibility

The varieties of castor seeds recommended for below mentioned states of India are given in the report

### States

- Andhra Pradesh
- Uttar Pradesh
- Gujarat
- Tamil Nadu
- Karnataka
- Maharashtra
- Rajasthan
- Haryana
- Punjab
- For all states
- For entire country

### Remunerative Intercropping Systems with Castor

Intercropping system	Row proportion	Recommended states
Castor + Pigeon pea	1:1	Gujarat, Andhra Pradesh
Castor + Cowpea	1:2	Gujarat, Andhra Pradesh
Castor + Urd bean	1:2	Gujarat, Andhra Pradesh
Castor + Mung bean	1:2	Gujarat, Andhra Pradesh
Castor + Cluster (vegetable)	1:1	Andhra Pradesh
Castor + Groundnut	1:5 or 1:7	Andhra Pradesh, Tamilnadu, Karnataka
Castor + Groundnut (Bunch)	1:3	Gujarat
Castor + Soybean	1:1	Bihar

### **Castor Cultivation FAQ**

- Why is castor an annual crop while it is actually a perennial?
- Is harvesting done manually or is it automated?
- Intercropping of castor with other plants?
- What are the safety laws that are followed in the castor industry – especially in areas where people come in contact with the seeds and/or castor meal?
- Is spreading castor meal as fertilizer not a problem to those who spread it?
- How resistant is the crop to salinity?
- What are the fertilizers commonly used for castor crop cultivation?
- Provide more details on castor meal as fertilizer
- Is organic castor oil produced anywhere?
- How is soil fertility maintained?
- Is there a danger to the flora and fauna in the region owing to the toxicity of castor beans?

**This chapter explains in detail about castor crop cultivation and also provides yield data under different soil and climatic conditions**

### **Castor Cultivation & Yields in India – Points**

- Despite phenomenal increase witnessed in the production and productivity of castor over the last ten years, there still exist wide regional disparities in the per hectare yields of castor.
- With the exception of Gujarat, where the per hectare yields (1630 kg/ha) have registered threefold increase since 1970, the general productivity levels of castor in all other parts are around 500 kg/ha. A multitude of factors such as its cultivation in sub-marginal and marginal lands under rainfed conditions with practically little or no inputs, use of poor quality seed and inefficient crop management are responsible for such dismal yield.
- The area under castor in Andhra Pradesh has gradually declined in the last five decades.
- Ruling varieties and hybrids of castor in India include Aruna, Sowbhagya, Bhagya, Kranti and GCH-4.

## Chapter 6 – Castor Oil End-Uses

The ever-expanding end uses of castor oil and its derivatives make it imperative for businesses and companies to have an updated and comprehensive knowledge of the various applications of each castor oil derivative. This chapter provides extensive details on the current, emerging and future possible end-use applications of castor oil and its derivatives. Special emphasis is given to providing real-life and exclusive data for niche applications such as the use of castor oil to produce polyurethane, nylon 6 and nylon 11. A detailed evaluation is also provided on the suitability of castor oil as a biodiesel feedstock.

### Key Sections

#### 6.1 Current End-uses for Castor Oil and Derivatives

##### 6.1.1 End Uses – by Castor Oil Grade / Derivative

##### 6.1.2 Castor Oil & Castor Oil Derivatives Uses – By Industry

- Agriculture
- Food
- Textile Chemicals
- Paper
- Plastics & Rubber
- Cosmetics & Perfumeries
- Electronics & Telecommunications
- Pharmaceuticals
- Paints, Inks & Additives
- Lubricants
- Bio-fuels
- Other End Products Where Castor Oil & Derivatives are Used
  - Medicinal Uses of Castor Oil
    - Anti-cancer Drugs
    - Antifungal Drugs
    - Heart & Blood Pressure Drugs

- Human Immunodeficiency Virus (HIV) Protease Inhibitors
- Organ Transplant Drugs
- Use of Castor Oil to Encourage Onset of Labour

#### 6.1.3 Use of Castor Oil in High-end Derivatives

### 6.2 Future Possible End-uses and End User Industries for Castor Oil and Derivatives

#### 6.2.1 Biopolymers and Castor oil

- Building Blocks for Polymers-based on Natural Oils
  - Biopolymers in Durables
  - Castor Oil Polyurethane
- Features of Castor Oil Based Polyurethane
  - A Typical Polyurethane Formulation
- Nylon
- Castor Oil Derivatives for Other Plastics
- Research & Trends in Castor Oil Based Biopolymers

#### 6.2.2 Castor Oil as a Feedstock for Biodiesel

- Can castor oil become an efficient bio-fuel and bio-diesel?
- Cost of Castor Oil
- Evaluation Table for Castor Oil as Biodiesel Candidate
- A comparative study of physical properties of castor oil biodiesel and its blends with conventional fuel
- Preliminary Inference for "Can Castor Oil Make a Good Biodiesel?"
- Some useful research info on biodiesel from castor oil

#### 6.2.3 Other Possible Future Uses

## **Current End Uses for Castor Oil & Derivatives**

### **12-HSA**

12 HSA is used in grease manufacture, plastics lubrication and as a raw material for the synthesis of more complex chemicals. It is used as a high hydroxyl castor based wax, as a wax ingredient.

When reacted with an ester, 12 HSA provides a hard finish for the automotive and small appliance industries.

Both HCO and 12 HSA have enjoyed popularity with the growth of lithium complex greases, which are growing to be the largest segment of the grease market. These greases have excellent heat tolerance like the sodium greases and the water resistance of calcium greases. The addition of 12 HSA enhances the overall performance with better texture, improved heat stability and improved dropping points. It simplifies the grease manufacturing process because it no longer requires milling and homogenization steps that were normally used with lithium type greases.

12 HSA soaps are used in mineral oil-based multipurpose greases making it possible for grease to fill the requirements of a variety of needs in the automotive and truck greases.

***In cosmetics:*** 12 HSA may be used for gelling liquid petroleum to produce brilliance. It may be incorporated into cold creams and vanishing creams to give a jelly-like feeling.

***In paints:*** 12-HSA is reacted with acrylic esters to produce hard, durable thermosetting polymers used in high-quality automotive, industrial appliance and metal decorative finishes.

***In rubbers:*** 12-HSA functions as an activator and internal lubricant for natural and synthetic rubbers.



## **Nylon 11**

The process to make Nylon 11 from castor oil is quite involved and includes several reaction steps, but briefly, it is as follows:

Castor oil is converted to methyl ricinoleate by treatment with methyl alcohol. Methyl ricinoleate is pyrolysed at high temperature yielding heptaldehyde, methyl undecylenate and a small amount of fatty acids. Methyl undecylenate is hydrolysed to produce undecylenic acid. When undecylenic acid is treated with hydrogen bromide in a non-polar solvent in the presence of peroxide, reverse Markownikoff addition occurs and the main product is x-bromoundecanoic acid. This is then treated with ammonia to give x-aminoundecanoic acid, which is a crystalline solid. Aminoundecanoic acid is the starting material for nylon-11.

### A comparative study of physical properties of castor oil biodiesel and its blends with conventional fuel

Properties	Units	Petroleum Diesel	B10	B20	B100
Specific Gravity		0.8610	0.8643	0.8703	0.9268
Density	Kg/m <sup>3</sup>	861.0	864.3	870.3	926.8
Kinematic viscosity	mm <sup>2</sup> /sec	3.81	4.54	4.97	15.98
Flash Point	°C	68.3	85.3	88.7	190.7
Heating value	kJ/kg	47216.4	44427.6	44780.4	37900.8
Copper strip corrosion		1a	1a	1a	1b
Carbon residue	Mass (%)	0	0.009	0.007	0.039
Cloud point	°C		-5	-7	-23
Pour point	°C	-6	-26	-30	-45

Source: <http://www.icrepq.com/full-paper-icrep/222-barajas.pdf>

### Global Companies Associated with Castor Oil Based Nylon Production

Company	Grades
Arkema	11 (homopolymer)
BASF	6, 10
DuPont	6, 10: 10, 10
DSM	4, 10
EMS	6, 10 10, 10 '10T' (PPA)
(PPA)	6, 10 10, 10
Evonik	6, 10

The scope of applications and potential markets for castor oil and its derivatives are explained in this chapter. Profiles of end users of castor oil derivatives are given. In addition, this chapter also analyzes castor oil's suitability as a replacement for biodiesel.

## Chapter 7 – Castor Seeds

A number of research efforts have been initiated towards development of hybrid and high-yield castor seeds. These efforts will be crucial in expanding the crop cultivation worldwide. This chapter provides key inputs related to castor seeds, and has a special emphasis on providing critical data that will be of special interest to those keen on exploring investing in this industry – data related to prices, and inputs on castor seed varieties including trends in hybrid castor seeds.

### Key Sections

- 7.1 Introduction to Castor Seeds
- 7.2 Castor Seeds Production & Supplies
- 7.3 Castor Seeds Prices & Trends
- 7.4 Castor Seeds Packaging & Storing
- 7.5 Castor Seed Varieties
- 7.6 Castor Seed Factoids

### Castor Seed Prices & Trends

The average spot prices provided for specific months over a 3 year period to demonstrate the increase and volatility in prices

Year	Average Price (\$ / T)	Year	Average Price (\$ / T)
2005 May	400	2009 Mar	490
2005 Nov	330	2009 Jul	540
2006 Mar	340	2009 Nov	640
2006 Jul	340	2010 Mar	640
2006 Nov	400	2010 Oct	812
2007 Mar	460	2011 Jul	1069
2007 Jul	480	2012 Jan	736
2007 Nov	500	2012 May	550
2008 Jan			
2008 Mar			
2008 Jul			
2008 Nov			

**Apart from price details, this chapter also talks about castor seed production and supplies in major countries for the past ten years.**

## Chapter 8 – Castor Meal

Castor meal makes an excellent bio-fertilizer owing to its optimal composition of nutrients (especially N-P-K). The toxicity in castor meal makes it unsuitable for use as animal feed, thus resulting in a lower price for the meal while compared with prices of competing oilseed-meals such as soymeal or rapeseed meal. This combination of high fertilizer value and a low price has resulted in an ever increasing demand for castor meal from the organic fertilizer market worldwide. This chapter provides details on composition, supply/demand, price data and related commercials for castor meal.

### Key Sections

- 8.1 Castor Meal Uses
- 8.2 Castor Meal Composition
- 8.3 Castor Meal Supply & Demand
- 8.4 Toxicity in Castor Meal
- 8.5 Energy Content in Castor Meal
- 8.6 Castor Meal – Other Points

### **Toxicity in Castor Meal**

The castor cake is mainly used as a fertilizer. It is unsuitable as an animal feed because of the presence of toxic protein called ricin and toxic allergen often referred to as CBA (castor bean allergen). However, it is noteworthy that none of the toxic components is carried into the oil.

Some methods for the detoxification of the cake have been attempted. These include

- Treatment with ammonia, caustic soda, lime and heat.
- When the cake is steamed, the ricin is detoxified and the allergen is inactivated.
- Another method of detoxifying castor seed meal involved the wet mixing with sal seed meal so that the toxic constituents of castor seed were neutralized by tannins.
- Detoxified and deallergenized castor meal (DDCM) is a by-product of an extraction process of the castor bean in Thailand, introduced in the 1990s. It has been claimed that DDCM can be safely used as animal feed. It is claimed that the extraction process is done in such a way that due to the action of heat, together with some base solubles, the castor meal is rendered non-toxic.

### Benefits of castor cake as a soil fertilizer

- Increasing yield
- Improving soil pH index
- Increasing cane yield and sucrose content in juice
- Increasing N content in grain and straw
- Controlling nematodes
- Increasing tuber yield

Plants best fertilized by castor de-oiled cake:

Maize, Sugarcane, Rice, Banana, Jute, Tomato, Wheat/Barley, Potato and Tobacco.

### Indian Castor Meal Exports

Year	Exports (in MT)
2003-04	65
2004-05	70
2005-06	200
2006-07	205
2007-08	330
2008-09	204
2009-10	240
2010-11	209
2011-12	341
2012-13 (Upto Sept 2012)	214

Source: SEA, India

**Detailed inputs on castor meal composition, its uses and demand-supply information are provided in this chapter.**

## Chapter 9 – Castor Oil Distribution & Logistic

Castor oil is transported for long distances – sometimes tens of thousands of kilometers - from the place of production to the place of consumption. This transportation also takes different forms, the primary means being by road and by ship transportation. The extensive logistics required in the castor oil business implies that producers and consumers of castor oil and derivatives have in-depth knowledge of the key aspects in castor oil storage, transportation and logistics. This chapter provides these inputs.

### Key Sections

#### 9.1 Castor Oil Storing & Packaging

##### 9.1.1 Castor Oil Storage

##### 9.1.2 Castor Oil Packaging

##### 9.1.3 Castor Oil Shelf Life

#### 9.2 Castor Oil Transportation & Logistics

##### 9.2.1 Distribution from Farms to Refinery

##### 9.2.2 Transport

##### 9.2.3 Cargo Handling

##### 9.2.4 Density & Volume Expansion

##### 9.2.5 Cargo Securing

##### 9.2.6 Risk Factors & Loss Prevention

- Temperature
- Humidity/Moisture
- Ventilation
- Biotic Activity



- Self-heating / Spontaneous Combustion
- Odour
- Contamination
- Mechanical Influences
- Toxicity / Hazards to Health
- Shrinkage / Shortage
- Insect Infestation / Diseases
- Castor Oil Storage during Transportation

## Risk Factors & Loss Prevention

### Contamination

<b>Active behavior</b>	Leaking oil leads to massive contamination and may make whole cargoes unusable. Of considerable significance with regard to tank cleaning is the iodine value, which is a measure of how strong a tendency the oil has to oxidation and thus to drying. Drying is particularly detrimental to tank cleaning, as the oil/fat sticks to the walls and can be removed only with difficulty. On the basis of drying capacity, oils are divided into nondrying, semidrying and drying oils. With an iodine value of 81 - 100, castor oil is a non-drying oil, which means that it does not dry significantly on contact with atmospheric oxygen and so the tanks are easily cleaned.
<b>Passive behavior</b>	Castor oil is sensitive to contamination by ferrous and rust particles and water (especially seawater). The tanks or barrels must be clean and in a thoroughly hygienic condition before filling.

**More such risk factors and prevention methods are discussed in this chapter**

## Chapter 10 – Prominent Castor Oil Producers

India is by far the largest producer and exporter of castor oil, followed by China and Brazil. However, many other countries – especially from South East Asia, Africa and South America - are showing significant interest in being large-scale producers of castor crop, castor oil and castor chemicals in future. This chapter provides profiles and details of the key companies involved in the castor oil industry, with a special focus on the leading Indian castor oil and castor oil derivative producers.

### Key Sections

10.1 Producers in India

10.2 Producers in China

10.3 Producers in Brazil

10.4 Other Suppliers

## **RPK Agrotech**

**Main Line of Business:** Castor oil and derivatives producer and trader

**Background:** RPK Agrotech was established in 2004 and focuses on castor oil exports.

**Products:** The Company focused on producing the basic castor oil grades. The company has also started trading of castor oil derivatives mainly HCO and 12 HSA, which the company gets made on job work basis. The company has a capacity to crush over 9000 MT of castor seed per month. It is currently (Dec 2008) setting up new plant with crushing capacity of castor seed with 250 MT per day.

For a complete list of products, please see the following URL –  
<http://rpkagrotech.com/products.php>

**Financials:** Approximately \$25 million

**Location:** The Company operates a manufacturing facility at KSEZ Kandla in the state of Gujarat. The other unit is at Bhachau, also in Gujarat.

**Address:**

Plot No 351, 2nd Floor,  
Sector 1/A, Gandhidham,  
Gujarat - 370201

[www.rpkagrotech.com](http://www.rpkagrotech.com)

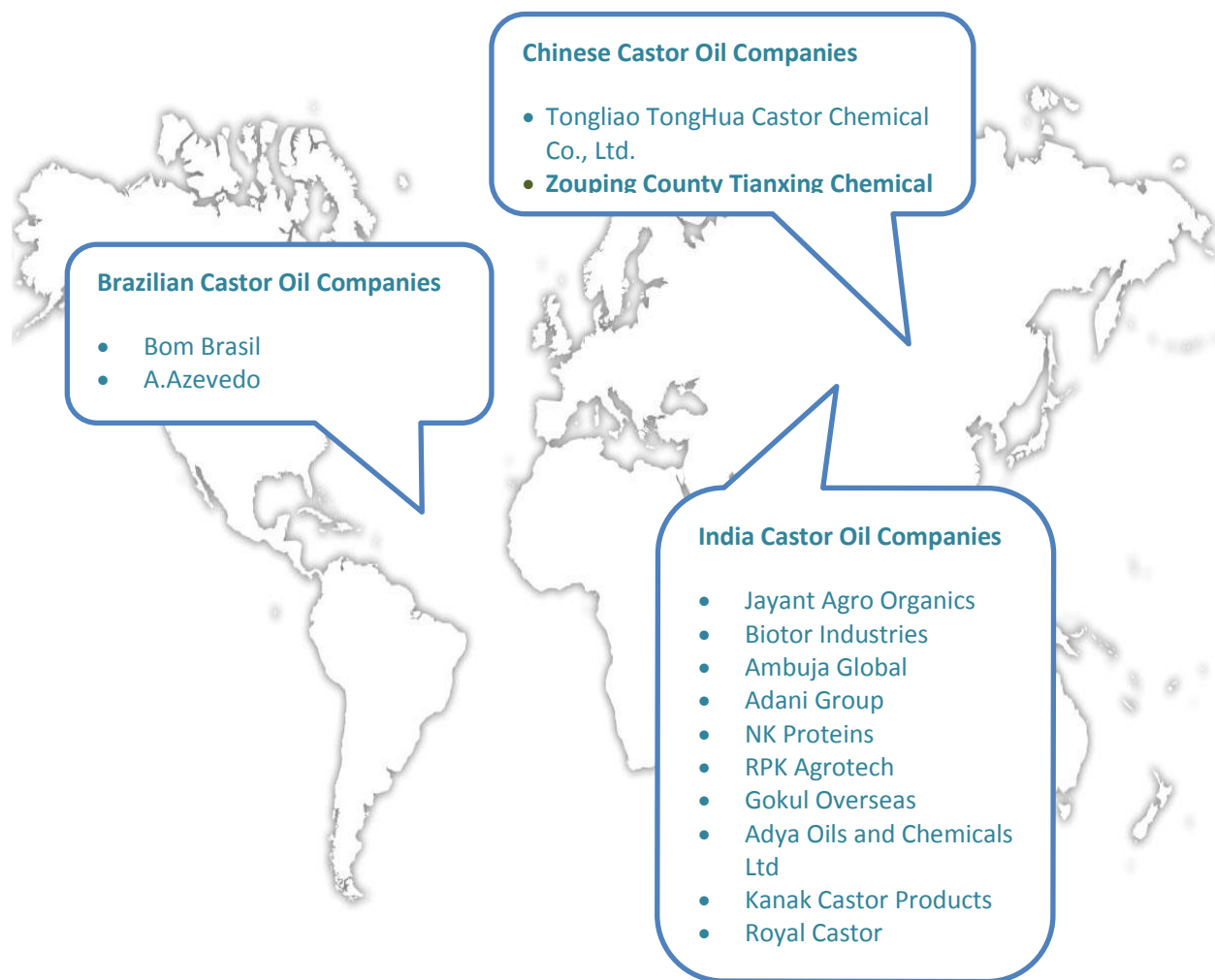
Detailed profiles are provided for over 10 prominent companies from India, China and Brazil that have ventured into the castor oil industry.

## Prominent Castor Oil Players

India Castor Oil Companies

Chinese Castor Oil Companies

Brazilian Castor Oil Companies



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## Price of the Comprehensive Castor Oil Report

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**Price Details:** The Comprehensive Castor Oil Report costs **US\$ 850**

**Updated:** January, 2014

You can purchase the report using a credit card from here -

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## About

CastorOil.in is the premier resource for the global castor oil and castor oil derivatives industry. Started in 2005 with a dedicated focus on the castor industry, CastorOil.in today serves as a crucial platform and opinion-leader for this industry. The CastorOil.in team is frequently interviewed by leading world media and frequently contributes articles and opinions to prestigious journals and reports. CastorOil.in today is synonymous with the global castor oil industry.