Comprehensive Castor Oil Report

A report on castor oil & castor oil derivatives

Updated April 2016

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The only acclaimed report
Critical for investment decisions
Current and emerging applications of oil and derivatives
Extensive market data – demand/supply
Comprehensive Castor Oil Report
Manufacturer and supplier details
Derivatives info - Market potential, manufacturing processes
Castor meal details
Crop cultivation

Preview of Comprehensive Castor Oil Report

The world's only market & industry report on castor oil & castor oil derivatives

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An Invaluable Guide to the Castor Oil and Castor Oil Derivatives Industry

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.

These accelerated research and commercial efforts in castor oil require a comprehensive information support resource that will ensure that all the relevant and critical information on the product, industry and market are available to the relevant entities. The Comprehensive Castor Oil Report was developed in order to satisfy this clear need.

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:

Production	• detailed inputs on the technology and processes for producing all major castor oil derivatives
Market segments	• inputs on the key end-user market segments
Cultivation	• extensive details on the critical aspects of castor crop cultivation
Companies	• profiles and details on the leading companies in this industry

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.

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
  - **Pressing / Expelling**
    - ❖ Expellers - Old Method
    - ❖ Expellers - New Methods
    - ❖ Manual Presses
    - ❖ Motor Driven Expellers
    - ❖ Large Scale Oil Expellers
  - **Single Chamber & Double Chamber Oil Expellers**
    - ▪ Single Chamber Design Oil Expeller
    - ▪ Double Chamber Design Oil Expeller
    - ❖ Typical Features of Presses / Oil Expellers
    - ❖ Special Facilities in New 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

Sample Topic – Chapter 1

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

- Sebacic Acid
- 12-HSA
- Undecylenic Acid
- Blown Castor Oil
- Ricinoleic Acid
- Heptaldehyde, Heptanoic Acid &Heptyl Alcohol
- Methyl 12-HSA
- Methyl Ricinoleate
- Methyl Undecylenate
- 2-Octanol
- Industrial/ Commercial Castor Oil
- Dehydrated 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

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.

Sulfonated Castor Oil

Sulfated castor oil, also known as turkey-red oil, represents one of the earliest chemical derivatives of castor oil.

The traditional method of preparing turkey-red oil is to add concentrated sulfuric acid at a controlled rate to castor oil over a period of several hours with constant cooling and agitation of the reaction mass to maintain a temperature of 25-30°C. After acid addition is complete, the reaction mass is washed then neutralized using an alkali solution or an amine. ***More from the report***

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 Seeds and Castor Oil

- Global Castor Seed Production 2011-14
- India Castor Seed Production, Area Harvested and Yield
- Global Castor Seed Scenario 2014-15 and Supply Scenario Predictions
- Global Castor Oil Production for the Period of 2005 -2014 (in '000 T)
- Summary of Castor Oil Production, Imports and Exports from Prominent Countries/Regions - 2013 -14 data (in '000 Tons)
- Global Imports of Castor Oil
- Global Castor Oil Imports - Trends for the Period of 2013-14 ('000 T)
- Export Volumes of Castor Oil from India to Major Importers (in MT)
- World Castor Seed Balance Sheet (000 MT)

2.4 Indian Castor Oil Industry

- Indian Castor Scenario 2015-16

2.4.1 Castor Oil Exports - Historical Scenario

2.4.2 Castor Oil Exports - Current Scenario

- Region-wise Indian Exports of Castor Oil 2015
- Indian Castor oil Exports to China

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 2015-16

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

Sample Topic – Chapter 2

Indian Castor Oil Industry

Indian Castor Scenario 2015-16

Castor Balance Sheet	***2014***	***2015***	***2016 (Est.)***
	In MTs	***In MTs***	***In MTs***
Opening Stock of Castor seed	*45000*	*275000*	*616000*
Unreported Stock available	*0*	*275000*	*0*
Crop Size	*1130000*	*1506000*	*1620000*
Total Supply of Castor Seed	*1580000*	*2056000*	*2236000*
A. Total Qty. in Terms of Oil (46%)	***726800***	***945760***	***1028560***
Less			
1. Actual exports of Oil from India	*410797*	*436168*	*458000*
2. Stock transfer of Oil from India	*19005*	*56305*	*0*
3. Derivatives	*120000*	*120000*	*126000*
4. Domestic Consumption	*50000*	*50000*	*55000*
B. Total Usage (1+2+3+4)	***599802***	***662473***	***639000***
C. Surplus/Shortage (-) Oil (A-B)	***126998***	***283287***	***389560***
In terms of Seed (1 MT Oil = 2.1739 MT seeds)	***276080***	***615838***	***846864***
i.e. rounded off	***275000***	***616000***	***847000***

Source – The Solvent Extractors' Association of India

Supply and Demand of Castor oil

Country	Production (000'T)
India	860.2
China	20
Brazil	76
Total	880.2
Country	Imports
China	230
Europe (27)	151
USA	50
Thailand	18
Brazil	5
Total	454
Country	Exports
India	470
Total	470

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
- Polyamides
- Coating, Paints, Inks & Resins
- Personal Care & Detergent
- Surfactants
- Other Oleochemicals

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.

Sample Topic – Chapter 2

Growth Prospects for Biobased Products

Market segment	Market size in 2014 ($billion)	CAGR 2014-20
Biofuels	99	15%
Plant extracts	30	3.5%
Biopolymers	3.7	14.5
Bulk chemicals	23	13.4%
Bio-active ingredients	23-33	7.2%
Oleochemicals	30.3	6.4%
Enzymes	7.1	8.2%

Region-wise Indian Exports of Castor Oil 2015

	YEAR		
	2014	**2015**	**2016 (Est.)**
Europe	111135 MT	124330 MT	125000 MT
USA	42943 MT	46893 MT	46000 MT
China	161655 MT	192050 MT	192000 MT
Others	95064 MT	72895 MT	95000 MT
Total (a)	410797 MT	436168 MT	458000 MT
Stock transfer – **Europe** **Malaysia**	 6600MT 12405 MT	 14500 MT 41805 MT	 - -
Total (b)	19005 MT	56305 MT	
Gross Total (a+b)	**429802 MT**	**492473 MT**	**458000 MT**

Global Castor Seed Production: 2011-14

	World Production of Castor Seed						
Country	**Production ('000/T)**			**Area Harvested ('000/Ha)**		**Yield (T/H)**	
	2013-14	**2012-13**	**2011-12**	**2012-2013**	**2011-2012**	**2012-2013**	**2011-2012**
Brazil	30	25	141	128	219	0.19	0.64
China	180	180	180	210	210	0.86	0.86
India	1200	1070	1,580	1,120	1,270	0.96	1.24
Other Countries	110	106	105	176	177	0.6	0.59
World	1520	1381	2,006	1,634	1,877	0.85	1.07

Chapter 3 Castor Oil Chemicals & 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.

Key Sections

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

Sample Topic – Chapter 3

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

Pale Pressed Castor Oil

CAS Number	8001-79-4
Flash Point	>440°F, >227°C
HCC	V6
Boiling Point	>450°F,>232°C
Vapour Density	>Air
Colour Gardner	2 Max
Acid Value	1.5
% Moisture & Volatile	0.25 Max
Hydroxyl Value	160-168
Iodine Value	83-88
Saponification Value	175-185
Viscosity @ 25°C	6.3-8.9

Dehydrated Castor Oil

CAS Number	61789-45-5
Appearance	Viscous liquid
Colour Gardner	6 Max
Acid Value	5 Max
Iodine Value	123 Min
Hydroxyl Value	25 Max
Saponification Value	185 – 194
Viscosity at 30 ºC	1.6 to 2.5 (poise 61 sec B4 cup)
Viscosity Gardner	G – J

First Special Grade Castor (FSG) Oil

Properties	Test Method	Magnitude
Free Fatty Acid(mg KOH/gm)	Aocs 13e.92	1.0% Max
Acid Value % (mgKoH / gm)	Aocs CaSa – 40	2.0% Max
Moisture & Volatiles %	Aocs Ca 2e – 25	0.25 % Max
Colour on Lovilond		
1" Cell (Y+5R)		2.2 Yellow, 0.3 Red Max
5 ¼" Cell (Y+5R)	Aocs Cc 13E – 92	20 Yellow, 2.0 Red Max
Colour Gardner		3 Max
Iodine Colour		4 Max
Iodine Value (By Wiss, gI 2 / 100g)	Aocs cd 1.25	82 – 90
Saponification Value (mgKoH / gm)	Aocs cd 3.25	177 – 185
Unsaponifiable Matter		1.0 % Max
Hydroxyl Value mgKoH / gm	Aocs cd 13-60	160 Min.
Density at 30°C	Aocs 10C – 95	
Specific gravity 15°C	Aocs Cc-10G-25	0.952 – 0.965
Viscosity at 20°C Pas		9.5 – 11.0
Viscosity at 25°C Pas		6.0 – 9.0
Viscosity Gardner		U – V
Refractive Index at 20°C	Aocs cc 7.25	1.477 – 1.481
Peroxide Value	Aocs cd 8.53	5 Max
Optical Rotation		+3.5° to +6.0°
Solubility		Complete soluble in Alcohol without turbidity
Ricinoleic Acid Content	GC	85% Min
Insoluble Impurities	Aocs Ca 3a – 36	0.02% 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 2011/12, 2014/15 and 2016

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

SAMPLE TOPIC

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	Price (US$/MT)
2002	675
2003	925
2004	850
2005	925
2006	775
2007	1025
2008 (Feb)	1160
2008 (June)	1350
2009 (Jan)	1050
2009 (June)	1104
2010 (Jan)	1330
2011	1832
2012	1428
2013	1180
2014	1396
2015	1222

A Snapshot of Castor Seed, Castor Oil & Castor Cake Prices in Feb 2016

Product	Price
Castor seed	463
Castor oil	987
Castor cake	74
All prices in US $ / Metric Ton, FOB India	

By Feb 2016, we see that the prices have decreased further from those in Mar 2015.

Historical and current price details are provided for castor seed and oil. This chapter also talks about price volatility in castor seed & oil and the factors that affect prices and influence castor trade.

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 Verities Recommended in India - Statewise
- Castor Verities in Gujarat
- Development of Pistillate Lines
- Development of Promising Inbred Lines and Hybrids[1]
- International Germplasm Center

5.7 Yields for Castor Seeds and Castor Oil from Seed
- Castor Seed Yield
- Castor seed yields trends
- Castor Oil Yield

5.9 Impact of agronomic practices on productivity of castor seeds
5.8 Castor Cultivation FAQ

SAMPLE TOPIC

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

Renumerative 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

Detailed answers to the following questions and more are provided

- 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

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

SAMPLE TOPIC

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.

Castor Oil Use in Cosmetics & Perfumeries

End Products	*Castor Products & Derivatives Used*
a. Perfumery Products b. Lipsticks c. Hair Tonics d. Shampoos e. Polishes f. Emulsifiers g. Deodorants	a. Castor Oil b. Castor Oil Esters c. Undecylenic Acid d. Castor Wax e. Zinc Ricinoleate f. Heptaldehyde g. Heptanoic Acid h. Undecylenic Acid i. Heptyl Alcohol j. Ethyl Heptoate k. Heptyl Acetate

Castor Oil for Biodiesel

A special, detailed section on the use of castor oil for biodiesel is provided, with comparisons and insights from technical and commercial aspects

Can castor oil become an efficient bio-fuel and bio-diesel?

This question is answered by analyzing the following:

- *Characteristics of oils or fats affecting their suitability for use as fuel*
- *Characteristics of efficient bio-fuels and bio-diesels*
- *How does the bio-diesel derived from castor oil rate on the above aspects?*
- *Based on the above three aspects, preliminary inference for "Can Castor Oil Make a Good Biodiesel?"*

Biodiesel Requirements (ASTM, 2003a)

Properties	Test Methods	Limits	Units
Flash Point (closed cup)	D 93	130.0 minimum	°C
Water & Sediments	D 2709	0.050 maximum	% volume
Kinematic Viscosity (40°C)	D 445	1.9-6.0	mm^2/s
Sulfated Ash	D 874	0.020 maximum	% mass
Sulphur	D 5453	0.05 maximum	% mass
Cetane Number	D 613	47 minimum	
Cloud Point	D 2500	Higher than that for petro-diesel	°C
Carbon Residue	D 4530	0.050 maximum	% mass
Acid Number	D 664	0.80 maximum	mg KOH/g
Free Glycerine	D 6584	0.020	% mass
Total Glycerine	D 6584	0.240	% mass
Phosphorus Content	D 4951	0.001 maximum	% mass
Distillation Temperature (atmospheric equivalent temperature, 90% recovered)	D 1160	360 maximum	°C

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^3*	*861.0*	*864.3*	*870.3*	*926.8*
Kinematic viscosity	*mm^2/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

SAMPLE TOPIC

Castor Seed Prices & Trends

The average spot prices provided for specific months over a 10 year period to demonstrate the increase and volatility in prices

Year	Average Price ($ / T)
2005 May	400
2005 Nov	330
2006 Mar	340
2006 Jul	340
2006 Nov	400
2007 Mar	460
2007 Jul	480
2007 Nov	500
2008 Mar	600
2008 Jul	700
2008 Nov	650
2009 Mar	490
2009 Jul	540
2009 Nov	640
2010 Mar	640
2010 Nov	822
2011 Jul	1069
2012 Jan	736
2012 May	550
2012 Dec	677
2013 Jan	610
2013 July	580
2014 Jan	624
2014 Jun	669
2014 Dec	740
2015 Jan	718
2015 Mar	588
2015 Dec	570
2016 Jan	519
2016 Feb	455 (BCE)

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

SAMPLE TOPIC

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 as 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	383
Apr '13-Jan '14	415
Apr '14-Jan '15	335

Source: SEA, India & Others

Chapter 9 Castor Oil Distribution & Logistics

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

SAMPLE TOPIC

Risk Factors & Loss Prevention

Contamination

Active behavior	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.
Passive behavior	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.

10.1 Producers in India
10.2 Producers in China
10.3 Producers in Brazil
10.4 Other Suppliers

SAMPLE TOPIC

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 is 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 (Mar 2015) operating with crushing capacity of castor seed excess of 250 MT per day, with solvent extraction technology.

Main castor grades and derivatives

- Commercial Castor Oil
- Refined Castor Oil
- Pale Pressed Grade Castor Oil
- Hydrogenated Castor Oil
- 12 Hydroxy Stearic Acid
- Castor seed Extraction Meal

They also have subsidiary companies that take care of transportation and warehousing activities.

Financials: Approximately $25 million

Location: The company operates a refining 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

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

SAMPLE TOPIC

Appendix 1

Chinese Sebacic Acid Supply-Demand Scenario for 2015

- Export: 48000MT
- Domestic: 22000MT
- Total Production: 70000MT
- Total Production in 2014: 61900MT
- Total Production in 2013: 68000MT
- There was hence an increase in production of about 13% between 2014 and 2015

Prominent Castor Oil Players

- India Castor Oil Companies
- Chinese Castor Oil Companies
- Brazilian Castor Oil Companies

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List of References

List of Organizations from Which Data have been Sourced

- Government of India and State Government of Gujarat Investment data
- USDA-ARS - http://www.ars.usda.gov/is/AR/archive/jan01/plant0101.htm
- Pharmexcil India
- FAO
- MCX, India
- Arkema Inc
- Fujitsu Limited http://www.fujitsu.com/global/news/pr/archives/month/2006/20061207-01.html
- Icynene Incwww.icynene.com
- SolarPlastics,Inchttp://www.solarplastics.com/solarplastics/client/materials_pdf/Elf_Atofina_Nylon_11-12_pro.PDF
- JayantAgro-Organics Limited http://www.jayantagro.com/products.htm
- Biotor Industries Limited http://www.biotorindustries.com/castor-oil-products.html
- Gujarat Ambuja Exports Ltd http://www.ambujaglobal.com/castor_meal.php
- Adani Group www.adanigroup.com
- N. K. Proteins Limited http://www.nkproteins.com/index.php?file=caster-product
- RpkAgrotechhttp://rpkagrotech.com/products.php
- Tianxing Chemical Industry Co., Ltd. http://www.tianxingchem.com
- Solvent Extractors' Association of India http://www.seaofindia.com/cdn/gallery/9/2ea17b9db29afc9fdc29390322f714f5.pdf
- Solvent Extractors' Association of India http://www.seaofindia.com/cdn/gallery/9/2ea17b9db29afc9fdc29390322f714f5.pdf

References from Journals

- Pradeep G. Shende, Abhijit B. Jadhav, Shrikant B. Dabhade; Journal: Pigment & Resin Technology, Year: 2002
- Gonzaga, D.P.; Murakami, C.R.; Chierice, G.O.; Altafim, R.A.C. Electrical Insulation, 1998. Conference Record of the 1998 IEEE International Symposium on Volume 1, Issue , 7-10 Jun 1998 Page(s):181 - 185 vol.
- Wiley Interscience http://www3.interscience.wiley.com/journal/112724331/abstract?CRETRY=1&SRETRY=0

References from Books

- Karlheinz Hill, Pure Appl. Chem., Vol. 72, No. 7, pp. 1255–1264, 2000

References from Websites

- Internal databases of CastorOil.in comprising vast amounts of commercial data
- http://www.ciara.com.ar/estadize.htm, European Union Data / Statistics
- http://www.biochemsoctrans.org/bst/028/0972/0280972.pdf
- http://www.crayvallac.com/inks/download/Castor_Wax_Tec_Bulletin.PDF
- http://www.icrepq.com/full-paper-icrep/222-barajas.pdf
- http://www.biodiesel.org/resources/reportsdatabase/reports/gen/20000501_gen-308.pdf
- http://www.biodiesel.gov.br/docs/JAOCSMeneghetti2006.pdf
- http://cat.inist.fr/?aModele=afficheN&cpsidt=18403364
- *https://www.zauba.com/import-SEBACIC+ACID/hs-code-2917-hs-code.html*

Price of the Comprehensive Castor Oil Report

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

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