

## **REVIEW**

# ***Ricinus communis*: Ethnomedicinal uses and pharmacological activities**

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**Abstract:** *Ricinus communis* L. (Castor oil plant) is an important medicinal plant belonging to family Euphorbiaceae. Its phytochemistry, biological and pharmacological activities, and ethnomedicinal uses have been reviewed in the present study. The reported chemical constituents showed the presence of flavonoids, phenolic compounds, fatty acids, amino acids, terpenoids, phytosterol etc. The compounds have been reported to exhibit anticonceptive, antidiabetic, antifertility, anti-inflammatory, antimicrobial, antioxidant, hepatoprotective, insecticidal and wound-healing activities. They also showed free radical scavenging and Hg scavenging activities, and repellent properties. Various parts of *R. communis* have been widely used in traditional medicine such as abdominal disorders, arthritis, backache, muscle aches, bilharziasis, chronic backache and sciatica, chronic headache, constipation, expulsion of placenta, gallbladder pain, period pain, menstrual cramps, rheumatism, sleeplessness, and insomnia. Castor oil plant has also revealed toxic effects due to the presence of ricin (protein) and ricinine (alkaloid). Comparatively, ricin is more toxic. But still there is need of more research to be conducted with reference to its medicinal importance (particularly exploring of medicinal recipes) and active compounds responsible for various activities.

**Keywords:** *Ricinus communis*, phytochemical constituents, terpenes.

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## **INTRODUCTION**

*Ricinus communis* L. (Castor oil plant) is an annual or perennial shrub belonging to the family Euphorbiaceae. Leaves have long petiole and palm like lobed blades. Inflorescence consists of unisexual flowers which are arranged at the top of the axis in the form of panicles; male flowers lie towards the base and female flowers towards the apex; perianth leaves (sepals and petals) are inconspicuous and caducous. Fruit is three chambered, globose capsule with soft spines (Jombo & Enenebeaku, 2007). When capsules mature, they split up into three cavities and the seeds are expelled out (Nair, 2009). Seeds are dorsiventrally flattened, ovoid, fleshy, and covered by grayish, silvery or light brown generally dotted seed coats (Smith, 1986).

*Ricinus communis* has a much more reasonable origin. The word *Ricinus* means 'tick' and the specific epithet *communis* stands for 'common' in Latin. The plant is so named because its seed looks like 'tick' and its occurrence is 'common' in many parts of the world (Anonymous, 2004).

*R. communis* is the only species in its genus, and comprises 22 subspecies and varieties as well as a handful of cultivars developed by ornamental horticulturalists and plant breeders (O'Connell and Skowronski, 2006).

*R. communis*, being a native of Africa and India, is distributed throughout the tropical, subtropical and temperate regions of the world. It is mostly found in waste places and is believed to be densely growing weed (Nair, 2009).

Since ancient time the castor oil has been used as a curative means in local medicines throughout the world. In Egypt the seeds of the plant have been discovered in tombs in BC 4000. The past records show that the castor oil was used as medicine for the treatment of eye irritations in Egypt (Anonymous, 2008).

The applications of castor seed oil for light and as an ointment have been documented by Greek travelers, Herodotus and others. The use of Castor seeds oil for light in lamps, and as a laxative in folk medicine has been reported in India since BC 2000. It has been known from the folk medicine that in China for hundreds of years *R. communis* seeds and their oil has been used for internal or external application in dressings, stimulation of childbirth and expulsion of the placenta. (Anonymous, 2007).

The medicinal uses of castor oil have also been reported (table 4) in countries such as Persia (for epilepsy), Africa, Greece, Rome, Southern Europe and America. In earlier Roman period the castor oil plant was called Palma Christi which stands for 'into hand of Christ'. Nowadays it is also sometimes called by this name (Anonymous, 2008).

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There are numerous everyday applications of *R. communis* in human life; the oil of the seeds is used in varnishing the cloths as well as armors; the castor oil also plays a role in making of various articles such as wax, polish, coloured chalks, candles and carbon papers (Jombo and Enebeaku, 2007). Its utilization has been made with confidence for the treatment of numerous diseases such as arthritis, asthma, boils burns, cancer, carbuncles, catarrh, chancre, cholera, cold, colic, craw-craw (an itching skin disease) and convulsions (Jombo and Enebeaku, 2007).

A good amount of work regarding pharmacological, phytochemical, toxicological and to some extent biological activities of *R. communis* has been reported (Visen *et al.*, 1992; Okwuasaba *et al.*, 1997; Onwuliri and Anekwe, 2001; Leonardo *et al.*, 2001; Ross, 2001; Yuldasheva, 2002; Ross, 2003; Sandhyakumary *et al.*, 2003; Upasani *et al.*, 2003; Ilavarasan *et al.*, 2006; Ogunniyi, 2006; Zhang *et al.*, 2007; Chen *et al.*, 2008; Jombo and Enebeaku, 2008; Shokeen, 2008; Darmanin *et al.*, 2009; Garcia *et al.*, 2009; Singh *et al.*, 2009;

Ramos-López *et al.*, 2010; Salimon *et al.*, 2010; Islam *et al.*, 2010). But still there is need of more research work to be conducted with reference to its medicinal importance (particularly exploring of medicinal recipes) and active compounds responsible for various activities

### **Phytochemistry**

The reported chemical constituents showed the presence of amino acids (Onwuliri and Anekwe, 2001), fatty acids (Salimon *et al.*, 2010; Ogunniyi, 2006; Yuldasheva, 2002), flavonoids (Ramos-Lopez *et al.*, 2010), phenolic compounds (Singh *et al.*, 2009; Chen *et al.*, 2008; Ramos-López *et al.*, 2010), phytosterol (Zhang *et al.*, 2007), terpenoids (Darmanin *et al.*, 2009), and other compounds (Ross, 2003) such as alkaloids, etc (Jena and Gupta, 2012) which have been summarized in table 1. Some of the compounds / groups responsible for different activities have mentioned in table. 3.

### **Pharmacological activities**

*R. communis* exhibits various biological (table 2) and pharmacological activities such as abortifacient effect, acid phosphatase inhibition, acid phosphatase stimulation, agglutin activity, alkaline phosphatase inhibition (Ross, 2003), anticonceptive activity (Okwuasaba *et al.*, 1997), antidiabetic activity (Shokeen, 2008), antifertility effects (Sandhyakumary *et al.*, 2003), anti-inflammatory activity (Ilavarasan *et al.*, 2006; Singh *et al.*, 2009), antimicrobial activity (Garcia *et al.*, 2009; Ross, 2001; Islam *et al.*, 2010; Jombo and Enebeaku, 2008; Leonardo *et al.*, 2001), antioxidant activity (Singh *et al.*, 2009), free radical scavenging activity (Ilavarasan *et al.*, 2006), hepatoprotective activity (Visen *et al.*, 1992), Insecticidal activity (Upasani *et al.*, 2003), and repellent Properties (Grant, 2012).

### **Abortifacient effect**

In a study after treatment with the extract of castor plant seeds and a ricin-A chain for 3 days successively, the pregnancy of rabbits was finished. Progesterone (not estrogen) was reduced significantly in plasma level. All these were found in treated rabbits as compared to control ones. In addition to these, in rabbits treated with ricin-A chain the contents of protein in the placenta were decreased. While in Laparotomized rabbits production of lifeless foetuses, separated placenta and blood clots were seen (Nath *et al.*, 2011).

In another study on rabbits, extract of castor oil seed and a ricin-A chain were evaluated for the anti-implantation and anti-ovulation effects which showed a significant reduction in the weight gain of maternal body as well as the mortality of each and every foetus (Salhab *et al.*, 1999).

### **Acid phosphatase stimulation**

When the castor seed oil was used at the dose of 2 ml/animal by rats intragastrically, the intraluminal acid phosphatase liberation in the duodenum and jejunum, was increased but not in the stomach. (Ross, 2003).

### **Analgesic activity**

The water extract of *R. communis* root bark was evaluated at a dose of 100mg/kg & 200mg/kg while the standard drug diclofenac was used at a dose of 50mg/kg for Analgesic activity of. Albino mice of both sexes of six numbers in each group was undertaken for study of evaluated by eddy's hot plate method & tail immersion method. The results pointed out that the extract possessed significant anti-nociceptive activity against the two methods of pain in mice. The responsible phytochemical compounds may be saponin, steroids and alkaloids present in the plant (Rajeshkumar *et al.*, 2013).

### **Antiasthmatic activity**

A castor plant root extract (ethanolic) is considered to be useful for the cure of asthmatic effect as it is against allergy and acts as mast cell stabilizer due to presence of saponins and flavonoids phytochemicals in it. The saponin possesses mast cell stabilizing property while the flavonoids have a property to relax smooth muscle. They are also responsible for bronchodilator effect (Jena and Gupta, 2012).

### **Anti-fertility activity**

In a study *R. communis* seed extract was investigated for steroids and alkaloids phytochemical tests. The result was positive. As the sex hormones are steroids and methanol extract of seed of *R. communis* also revealed presence of steroids therefore, they produce anti-fertility effects (Jena and Gupta, 2012).

### **Anticonceptive effect**

The subcutaneous application of the ether extracts of seed of castor plant to the rats showed significant



**Fig.1:** *Ricinus communis* L.: A. Shoot of the plant, B. Flowers, C. Fruit (capsules) and D. Seeds

anticonceptive effect. It greatly changed the profile of the number and extent of vibratory movement of the uterine muscle, and also reduced response to oxytocin, ergometrine, acetylcholine and transmural electrical stimulation (TNS, 1-20Hz). The anticonceptive effect is considered to be caused in part by disturbance in the balance of the oestrogen / progesterone and direct effect on the uterus (Okwuasaba *et al.*, 1997).

#### **Antidiabetic activity**

Root extract of *R. communis* (RCRE) was evaluated for Antidiabetic effect. For this purpose (500mg/kg b.w) RCRE was administered to the diabetic rats for 20 days. The result revealed positive influences not only on fasting blood glucose but total lipid profile and liver and kidney functions were also affected. Only one (R-18) of total tested fractions revealed considerable antihyperglycemic activity. Thus *R. communis* can play an important role as an effective phytomedicine against diabetes (Shokeen *et al.*, 2008).

**Table 1:** Chemical Composition of essential oils of *Ricinus communis* L. reported from Literature.

Compound	MF	MW	Part	Reference
<b>Amino Acids</b>				
Alanine	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	89	Sd	Onwuliri and Anekwe, 2001
Arginine	C <sub>6</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub>	174	Sd	Onwuliri and Anekwe, 2001
Asparagine	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	132	Sd	Onwuliri and Anekwe, 2001
Aspartic acid	C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	133	Sd	Onwuliri and Anekwe, 2001
Glutamic acid	C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	147	Sd	Onwuliri and Anekwe, 2001
Glycine	C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	75	Sd	Onwuliri and Anekwe, 2001
Histidine	C <sub>6</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	155	Sd	Onwuliri and Anekwe, 2001
Isoleucine	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	131	Sd	Onwuliri and Anekwe, 2001
Leucine	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	131	Sd	Onwuliri and Anekwe, 2001
Lysine	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	146	Sd	Onwuliri and Anekwe, 2001
Methionine	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub> S	149	Sd	Onwuliri and Anekwe, 2001
Phenylalanine	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	165	Sd	Onwuliri and Anekwe, 2001
Proline	C <sub>5</sub> H <sub>9</sub> NO <sub>2</sub>	115	Sd	Onwuliri and Anekwe, 2001
Serine	C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	105	Sd	Onwuliri and Anekwe, 2001
Threonine	C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	119	Sd	Onwuliri and Anekwe, 2001
Tyrosine	C <sub>9</sub> H <sub>11</sub> NO <sub>3</sub>	181	Sd	Onwuliri and Anekwe, 2001
Valine	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	117	Sd	Onwuliri and Anekwe, 2001
<b>Fatty acids</b>				
Saturated fatty acids (SFA)	-----	----	SO	Salimon <i>et al.</i> , 2010
Unsaturated fatty acids (uFA)	-----	----	SO	Salimon <i>et al.</i> , 2010
Dihydroxystearic acid	C <sub>18</sub> H <sub>36</sub> O <sub>4</sub>	316	SO	Ogunniyi, 2006; Jena and Gupta, 2012
Eicosanoic acid	C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	312	SO	Ogunniyi, 2006
Linoleic acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	280	SO	Salimon <i>et al.</i> , 2010; Ogunniyi, 2006 Yuldasheva, 2002; Jena and Gupta, 2012
Linolenic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	278	SO	Ogunniyi, 2006
Oleic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	282	SO	Salimon <i>et al.</i> , 2010; Ogunniyi, 2006, Yuldasheva, 2002; Jena and Gupta, 2012
Palmitic acid	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	256	SO	Salimon <i>et al.</i> , 2010; Ogunniyi, 2006 Yuldasheva, 2002; Jena and Gupta, 2012
Ricinoleic acid	C <sub>18</sub> H <sub>34</sub> O <sub>3</sub>	298	SO	Salimon <i>et al.</i> , 2010; Ogunniyi, 2006
Stearic acid	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	284	SO	Salimon <i>et al.</i> , 2010; Ogunniyi, 2006 Jena and Gupta, 2012
Arachidic acid			SO	Jena and Gupta, 2012
Hexadecenoic acid			SO	Jena and Gupta, 2012
<b>Flavonoids</b>				
Gallic acid	C <sub>7</sub> H <sub>6</sub> O <sub>5</sub>	170	AP	Chen <i>et al.</i> , 2008; Singh <i>et al.</i> , 2009 Jena and Gupta, 2012
Gentistic acid,	C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	154	AP	Chen <i>et al.</i> , 2008; Singh <i>et al.</i> , 2009 Ramos-López <i>et al.</i> , 2010; Jena and Gupta, 2012
<b>Glycosides</b>				
kaempferol-3-O-β-D-xylopyranoside		---	AP,lf	Ramos-López <i>et al.</i> , 2010; Jena and Gupta, 2012
Kaempferol-3-O-β-rutinoside,	-----	----	AP,Lf	Ramos-López <i>et al.</i> , 2010; Jena and Gupta, 2012
Kaempferol-3-O-β-D-glucopy-ranoside	-----	----	AP,Lf	Ramos-López <i>et al.</i> , 2010; Jena and Gupta, 2012
Quercetin,	C <sub>15</sub> H <sub>10</sub> O <sub>7</sub>	302	AP,Lf	Singh <i>et al.</i> , 2009; Ramos-López <i>et al.</i> , 2010; Ross, 2003; Jena and Gupta, 2012
Quercetin-3-O-β-D-xylopyranoside,	-----	----	AP,lf	Ramos-López <i>et al.</i> , 2010; Jena and Gupta, 2012
Quercetin-3-O-β-D-glucopyranoside,	-----	----	AP,lf	Ramos-López <i>et al.</i> , 2010; Jena and Gupta, 2012
Quercetin-3-O-β-rutinoside	-----	----	AP	Ramos-López <i>et al.</i> , 2010; Jena and Gupta, 2012
Ricin	-----	----	Sd	Ramos-López <i>et al.</i> , 2010
Rutin	C <sub>27</sub> H <sub>30</sub> O <sub>16</sub>	610	AP	Chen <i>et al.</i> , 2008; Singh <i>et al.</i> , 2009 Ramos-López <i>et al.</i> , 2010; Jena and Gupta, 2012
<b>Phenolic compounds</b>				
Ascorbic acid	C <sub>6</sub> H <sub>8</sub> O <sub>6</sub>	176	Lf	Singh <i>et al.</i> , 2009
Ellagic acid	C <sub>14</sub> H <sub>6</sub> O <sub>8</sub>	302	Lf	Singh <i>et al.</i> , 2009; Jena and Gupta, 2012
Epicatechin	C <sub>15</sub> H <sub>14</sub> O <sub>6</sub>	290	Lf	Singh <i>et al.</i> , 2009; Jena and Gupta, 2012

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Compound	MF	MW	Part	Reference
Phytosterol				
Ergost-5-en-3-ol	-----	----	SO	Zhang <i>et al.</i> , 2007
Fucosterol	C <sub>29</sub> H <sub>48</sub> O	412	SO	Zhang <i>et al.</i> , 2007
Probucol analog	C <sub>31</sub> H <sub>48</sub> O <sub>2</sub> S <sub>2</sub>	517	SO	Zhang <i>et al.</i> , 2007
Stigmasterol	C <sub>29</sub> H <sub>48</sub> O	412	SO	Zhang <i>et al.</i> , 2007
Gamma-sitosterol	C <sub>29</sub> H <sub>50</sub> O	414	SO	Zhang <i>et al.</i> , 2007
Terpenes				
α-pinene	C <sub>10</sub> H <sub>16</sub>	136	Lf	Darmanin <i>et al.</i> , 2009
1,8-pinene			Sd	Jena and Gupta, 2012
1,8-cineole	C <sub>10</sub> H <sub>18</sub> O	154	Lf	Darmanin <i>et al.</i> , 2009; Jena and Gupta, 2012
Camphor	C <sub>10</sub> H <sub>16</sub> O	152	Lf	Darmanin <i>et al.</i> , 2009; Jena and Gupta, 2012
β-caryophyllene	C <sub>15</sub> H <sub>24</sub>	204	Lf	Darmanin <i>et al.</i> , 2009; Jena and Gupta, 2012
Alkaloids				
Ricinine	C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	164	Sd,lf,st	Onwuliri <i>et al.</i> , 2001; Jena and Gupta, 2012
N-demetilricinine	-----	----	Sd,Lf	Onwuliri <i>et al.</i> , 2001; Jena and Gupta, 2012
Miscellaneous				
Monoacylglycerol	-----	----	SD	Onwuliri and Anekwe, 2001
1, 2-Diacylglycerol	C <sub>5</sub> H <sub>6</sub> O <sub>5</sub> R <sub>2</sub>	----	SD	Onwuliri and Anekwe, 2001
Triacylglycerol	C <sub>55</sub> H <sub>98</sub> O <sub>6</sub>	854	SD	Onwuliri and Anekwe, 2001
Diricinoleoylstearyl glycerol (rrS)	-----	----	SO	Salimon <i>et al.</i> , 2010
Diricinoleoyloleoyl glycerol (rrO)	-----	----	SO	Salimon <i>et al.</i> , 2010
Diricinoleoyllinoleoyl glycerol (rrL)	-----	----	SO	Salimon <i>et al.</i> , 2010
Diricinoleoylpalmitoyl glycerol (rrP)	-----	----	SO	Salimon <i>et al.</i> , 2010
Triricinolein (rrr)	C <sub>57</sub> H <sub>104</sub> O <sub>9</sub>	933	SO	Salimon <i>et al.</i> , 2010
Allergens Ric e1 and Ric c3	-----	----	AP	Ramos-López <i>et al.</i> , 2010
Castor oil	-----	----	AP	Ramos-López <i>et al.</i> , 2010
Quinic acid,	C <sub>7</sub> H <sub>12</sub> O <sub>6</sub>	192	Lf	Ross, 2003
Ricin A	-----	----	Sd	Ross, 2003
Ricin A-B-1	-----	----	Sd	Ross, 2003
Ricin A-B-2	-----	----	Sd	Ross, 2003
Ricin -B	-----	----	Sd	Ross, 2003
Ricin-C	-----	----	Sd	Ross, 2003
Ricin-D	-----	----	Sd	Ross, 2003
Ricin-E	-----	----	Sd	Ross, 2003
Ricin, alpha	-----	----	Sd	Ross, 2003
Ricin, beta	-----	----	Sd	Ross, 2003
Ricin, gamma	-----	----	Sd	Ross, 2003
Ricin	-----	----	Lf, Sd	Ross, 2003
Ricine, n-demethyl	-----	----	Lf	Ross, 2003
Ricinoleic acid triglyceroides	-----	----	Sd	Ross, 2003
Ricinoleic acid	C <sub>18</sub> H <sub>34</sub> O <sub>3</sub>	298	Sd	Ross, 2003
Ricinus communis Agglutinin RCL-1	-----	----	Sd	Ross, 2003
Ricinus communis Agglutinin RCL-11	-----	----	Sd	Ross, 2003
Ricinus communis Agglutinin	-----	----	Sd	Ross, 2003
Ricinus communis Agglutinin-glycoprotein CB-1-A	-----	----	Sd	Ross, 2003
Ricinus communis hemagglutinin	-----	----	Sd	Ross, 2003
Ricinus communis lectin A-2	-----	----	Sd	Ross, 2003
Ricinus communis A-1	-----	----	Sd	Ross, 2003
Ricinus communis lectin RCA-1	-----	----	Sd	Ross, 2003
Ricinus communis lectin, alpha	-----	----	Sd	Ross, 2003
Ricinus communis lectin, beta	-----	----	Sd	Ross, 2003
Ricinus communis lectin, gamma	-----	----	Sd	Ross, 2003
Ricinus communis lectin	-----	----	Sd	Ross, 2003
Ricinus communis phyto agglutinin	-----	----	Sd	Ross, 2003
Ricinus lectin RCA-120	-----	----	Sd	Ross, 2003
Ricinus lectin	-----	----	Sd	Ross, 2003
Rutin	C <sub>27</sub> H <sub>30</sub> O <sub>16</sub>	610	Lf, Fl	Ross, 2003

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Compound	MF	MW	Part	Reference
Serine, phosphatidyl	C <sub>13</sub> H <sub>24</sub> NO <sub>10</sub> P	385	Sd	Ross, 2003
Shikimic acid	C <sub>7</sub> H <sub>10</sub> O <sub>5</sub>	174	Lf	Ross, 2003
Sitosterol beta	C <sub>29</sub> H <sub>50</sub> O	414	Lf,SO	Ross, 2003
Indole-3-acetic acid			Rt	Jena and Gupta, 2012
Lupeol			Sd	Jena and Gupta, 2012
30-Norlupan-3β-ol-20-one			Sd	Jena and Gupta, 2012

**Key:** MF = Molecular Formula, MW = Molecular Weight, AP = Aerial Parts, Fl = Flower, Lf = Leaf, Sd = Seed, SO = Seed Oil

**Table 2:** Biological activities of Castor Oil Plant (*Ricinus communis* L)

Organism	Extracts / constituents	References
<b>Antimicrobial activities</b>		
<i>Bacillus subtilis</i> and	Plant	Ross, 2001
<i>Staphylococcus aureus</i>	Plant	Ross, 2001
<i>Klebsiella pneumoniae</i>	Methanol and water extracts	Jombo & Enenebeaku, 2007
<i>Escherichia coli</i>	Methanol and water extracts	Jombo & Enenebeaku, 2007
<i>Proteus mirabilis</i>	Methanol and water extracts	Jombo & Enenebeaku, 2007
<i>Staphylococcus aureus</i>	Methanol and water extracts	Jombo & Enenebeaku, 2007
<i>Enterococcus faecalis</i>	Methanol and water extracts	Jombo & Enenebeaku, 2007
<i>Pseudomonas aeruginosa</i>	Methanol and water extracts	Jombo & Enenebeaku, 2007
<i>Escherichia coli</i>	Stem & leaf hexane extract	McGaw <i>et al.</i> , 2007
<i>Enterococcus faecalis</i>	Stem & leaf hexane extract	McGaw <i>et al.</i> , 2007
<i>Pseudomonas aeruginosa</i>	Stem & leaf hexane extract	McGaw <i>et al.</i> , 2007
<i>Staphylococcus aureus</i>	Stem & leaf hexane extract	McGaw <i>et al.</i> , 2007
<i>Klebsiella pneumoniae</i>	Plant	Jombo <i>et al.</i> , 2008
<i>Escherichia coli</i>	Plant	Jombo <i>et al.</i> , 2008
<i>Proteus vulgaris</i>	Plant	Jombo <i>et al.</i> , 2008
<i>Pseudomonas aeruginosa</i>	Plant	Jombo <i>et al.</i> , 2008
<i>Enterococcus faecalis</i>	Ca(OH) <sub>2</sub> & Castor oil	Garcia <i>et al.</i> , 2009
<i>Staphylococcus aureus</i>	Ca(OH) <sub>2</sub> & Castor oil	Garcia <i>et al.</i> , 2009
<i>Pseudomonas aeruginosa</i>	Ca(OH) <sub>2</sub> & Castor oil	Garcia <i>et al.</i> , 2009
<i>Streptococcus mutans</i>	Ca(OH) <sub>2</sub> & Castor oil	Garcia <i>et al.</i> , 2009
<i>S. sanguinis</i>	Ca(OH) <sub>2</sub> & Castor oil	Garcia <i>et al.</i> , 2009
<i>Enterococcus faecalis</i>	Endoquil (castor oil detergent)	Leonardo <i>et al.</i> , 2001
<i>Micrococcus luteus</i>	Endoquil (castor oil detergent)	Leonardo <i>et al.</i> , 2001
<i>Staphylococcus aureus</i>	Endoquil (castor oil detergent)	Leonardo <i>et al.</i> , 2001
<i>S. epidermidis</i>	Endoquil (castor oil detergent)	Leonardo <i>et al.</i> , 2001
<i>Streptococcus mutans</i>	Endoquil (castor oil detergent)	Leonardo <i>et al.</i> , 2001
<i>S. sobrinuss</i>	Endoquil (castor oil detergent)	Leonardo <i>et al.</i> , 2001
<i>Escherichia coli</i>	Plant	Ross, 2001 and Islam <i>et al.</i> , 2010
<i>Salmonella newport</i>	Plant	Ross, 2001 and Islam <i>et al.</i> , 2010
<i>Serratia marcescens</i>	Plant	Ross, 2001 and Islam <i>et al.</i> , 2010
<i>Streptococcus progens</i>	Plant	Ross, 2001 and Islam <i>et al.</i> , 2010
<i>Shigella flexneri</i>	Plant	Ross, 2001 and Islam <i>et al.</i> , 2010
<b>Anti amoebic activity</b>		
<i>Entamoeba histolytica</i>	Ethanol/water extract of root	Ross, 2001
<i>Entamoeba histolytica</i>	Ethanol/water extract of stem	Ross, 2001
<b>Anthelmintic activity</b>		
<i>Caenorhabditis elegans</i>	Stem & leaf hexane extract	McGaw <i>et al.</i> , 2007
<b>Insecticidal activity</b>		
<i>Callosobruchus chinensis</i>	Aqueous leaf extract	Upasani <i>et al.</i> , 2003
<i>Cosmopolites sordidus</i>	Aqueous leaf extract	Tinzaara <i>et al.</i> , 2006
<i>Culex pipiens</i>	Aqueous leaf extract	Aouinty <i>et al.</i> , 2006
<i>Aedes caspius</i> ,	Aqueous leaf extract	Aouinty <i>et al.</i> , 2006

Continued...

Organism	Extracts / constituents	References
<i>Culiseta longiareolata</i>	Aqueous leaf extract	Aouinty <i>et al.</i> ,2006
<i>Anopheles maculipennis</i>	Aqueous leaf extract	Aouinty <i>et al.</i> ,2006
<i>C. chinensis</i>	Mmethanolic leaf extract	Upasani <i>et al.</i> ,2003
<i>Callosobruchus chinensis</i>	leaf extracts	Upasani <i>et al.</i> ,2003
<i>Acromyrmex lundi</i>	Aqueous & acetone leaf extracts	Caffarini <i>et al.</i> ,2008
<i>Zabrotes subfasciatus</i>	Castor oil	Mushobozy <i>et al.</i> ,2009
<i>Spodoptera frugiperda</i>		Ramos-López <i>et al.</i> , 2010
Larvicidal activity		
<i>Anopheles arabiensis</i>	Crude extracts	Elimam <i>et al.</i> , 2009
<i>Culex quinquefasciatus</i>	Crude extracts	Elimam <i>et al.</i> , 2009

**Table 3:** Showing different activities by various compounds / groups present in *Ricinus communis* L.

Name of the compounds / groups	Activities	References
Saponin, steroids and alkaloids	Analgesic activity	Rajeshkumar <i>et al.</i> , 2013
	Antinociceptive activity	Jena and Gupta, 2012
Saponins and flavonoids	Antiasthmatic activity	Jena and Gupta, 2012
Steroids	Anti-fertility activity	Jena and Gupta, 2012
Flavonoids, alkaloids and tannins	Anti-inflammatory activity	Nath <i>et al.</i> , 2010
Methyl ricinoleate, Ricinoleic acid,		
12 octadecadienoic acid and methyl ester	Antioxidant activity	Jena and Gupta, 2012
Flavonoids	Antioxidant activity	Jena and Gupta, 2012
		Singh and Geetanjali,2015
Insecticidal, ovicidal and	oviposition prevention	Upasani <i>et al.</i> , 2003
Ricine	central nervous system stimulant effect	Williamson, 2002
RCA ( <i>Ricinus communis</i> agglutinin)	clots red blood cells	Helmenstine, 2001
Ricin	inactivates the ribosomes	Singh and Geetanjali,2015
Cytotoxic Activity		Singh and Geetanjali,2015
Ricinoleic acid analgesic and anti-inflammator		Singh and Geetanjali,2015

**Table 4:** Traditional Uses of Castor Oil Plant (*Ricinus communis* L.)

Diseases	Part Used	Treatment	Reference
Abdominal disorders	R	In Tanzania, hot water extract of dried root is used orally to treat diarrhea, stomach ulcers and stomachaches.	Ross, 2003
	AP	In Saudia, hot water extract of aerial parts is taken orally as a purgative and diuretic.	Ross, 2003
Aching feet	CO	Castor oil is used for aching feet. Simply smearing of some hand-warmed castor oil over feet is sufficient for immediate relief. For severe foot pain, enough amount of castor oil is applied over feet's problem areas which are wrapped in some plastic (such as cling film) and after that socks are put on before going to bed. Repeated application of this for a few weeks will eventually resolve most foot pain completely. Use of castor oil in very painful heel spurs (calcium deposits) is also useful.	Samantha,2010
Arthritis,backache, muscleaches CO	CO	Castor oil applied topically can give immense from arthritis, back pain and general muscle aches and soreness. A cloth soaked in castor oil is applied over the painful joint is covered with plastic (such as cling film). A hot water bottle placed over this (this method is also known as a' castor oil pack'). The heat will help the castor oil to penetrate the inflamed tissues and joints. Even without external heat, a castor oil pack will still work wonders. This can be done easily by putting the castor oil pack on before going to bed, leaving it to work overnight.	Samantha, 2010
Bilharziasis	L	In Senagal, a decoction of the dried leaves is externally applied for bilharziasis	Ross, 2003
Boils, sores and swellings.	L	Leaves are said to be used in the form of a poultice or fomentation on sores, boils and swellings.	Rana <i>et al.</i> , 2012
Chronicbackache and sciatica:	Sd	The kheer of erand seeds, after boiling them in milk, is a famous household remedy for the Sciatica-Lumbago Syndrome The same recipe is given to patients of other vata diseases like	Ayurved., 2001

Continued...

Diseases	Part Used	Treatment	Reference
Chronic headache	L	In Somalia, a handful of leaves are crushed and mixed with a cup olive oil. The mixture is applied to the head and 1 drop is placed in each nostril to treat chronic headache. The treatment is continued until the patient is free of pain.	Ross, 2003
Conjunctivitis	CO	Put 1-2 drops of Castor Oil twice daily for 3 days. It may sting a little in the beginning, but later on it soothes the eyes, and eradicates conjunctivitis.	Tunika, 2008
Constipation	CO	Varying in dose from patient to patient, castor oil is a simple and harmless purgative. Usually, 20 to 60 ml of it can be taken at bedtime with lukewarm milk. Castor oil works faster if it is taken during daytime	Ayurved. 2001
	CO	Half ounce of castor oil taken internally will have a quick and mild laxative effect, giving relief for constipation. To improve the taste, take the oil by floating in a glass of warm milk or mixing it with a fresh egg yolk.	Samantha, 2010
Expulsion of placenta	R	In Kenya and the decoction of the fresh root is taken orally to facilitate the expulsion of placenta or hasten parturition	Ross, 2003
	Sd	In Philpine, the seed is rubbed on the soles of the feet to hasten parturition or expulsion of placenta	Ross, 2003
Flatulence	L	Leaves coated with oil and warmed, are commonly applied over the abdomen to give relief in the flatulence in the children.	Rana <i>et al.</i> , 2012
Gallbladder pain	Oil	Pain from gallstones can be relieved by using hot castor oil packs. Place a castor oil pack over the area to relieve pain from gallbladder attacks	Samantha, 2010
Hair growth	Sd	In Japan, the water extract of seeds is externally applied to promote hair growth	Ross, 2003
Lumbago	R	Roots are administered in the form of a decoction for lumbago and allied complaints	Rana <i>et al.</i> , 2012
Muscular distortion	L	To treat muscular distortion, leaves are boiled in water, and the decoction is applied to distorted muscles	Ross, 2003
Paralyzed Limb	L	In Somalia, A handful of leaves are crushed and mixed with a cup olive oil. The oily extract is rubbed on the skin of paralyzed limb twice a day to restore activity	Ross, 2003
Period pain menstrual cramps	CO	Massage some hand-warmed castor oil over the lower abdomen to relieve period pain and menstrual cramping. Using the castor oil pack method over the lower abdomen can also help reduce menstrual irregularities and uterine and ovarian cysts. It's not unusual to feel some fluttering over the ovaries (either side or both) when a castor oil pack is applied.	Samantha, 2010
Poisoning		Fresh juice of leaves is reported to be used as an emetic in the poisoning by narcotics like opium.	Rana <i>et al.</i> , 2012
Repellent	L	The powdered leaves are used for repelling aphids, mosquitoes, white flies and rust mites.	Rana <i>et al.</i> , 2012
v Rheumatism	CO	The use of castor oil forms the basic treatment of rheumatoid rthritis in ayurveda. In its early stage taking 10 to 20 ml of castor oil and wo grams of the powder of dry ginger with a cup of warm milk daily for fortnight at bedtime reduces inflammation besides the early morning stiffness of the joints which is a characteristic feature of the diseases	Ayurved. 2001
Rigid knees	L	In Somalia, A handful of leaves are crushed and added to a cup of sesame oil. The mixture is filtered and applied to knees.	Ross, 2003
Secretion of milk.	L	The leaves have been also recommended in the form of a decoction or poultice, as an application to the breasts of women to increase the secretion of milk.	Rana <i>et al.</i> , 2012
Sexual diseases	L	In South Africa, hot water extract of leaves is taken orally as an emmenagogue. The powdered, dried root is applied locally as a vaginal antiseptic.	Ross,2003
	Sd	In South Korea, hot water extract of seeds is taken orally as an emmenagogue	Ross,2003
	L	In Mauritius, hot water extract of dried leaves is taken orally as an emmenagogue.	Ross,2003
Skin diseases	CO,L	Castor oil and its leaves are used in many poultices which are applied over inflamed conditions of joints, boils and the enlargement of lymph nodes. Its application is also beneficial if it is done on the cracked skin of the feet.	Ayurved. 2001
	CO	To treat small skin infections, apply a few drops of castor oil onto a plaster or band aid and apply it over the area you wish to treat each day. For a larger skin infection, use a piece of clean cloth soaked in castor oil instead	Samantha,2010
Sleeplessness, insomnia	CO	For the treatment of insomnia, a little castor oil is rubbed over the eyelids before going to bed. Castor oil applied in this way will bring about a feeling of deep relaxation for a peaceful slumber without the use of drugs.	Samantha, 2010

Continued...



Diseases	Part Used	Treatment	Reference
Stomach ache, colic	CO	To relieve stomachaches, hand-warmed castor oil is massaged gently over the abdomen and the bellybutton area (the navel). This relieves stomach pain and helps to expel trapped gas. Castor oil used in this way also helps relieve colic in newborns and helps them sleep.	Samantha, 2010
		An infusion of leaves is used for stomachache,	Rana <i>et al.</i> , 2012
Swollen lymph nodes	CO	Rub castor oil over the swollen lymph nodes each day and it will gradually shrink in size. Castor oil works by speeding up the circulation of the lymphatic system.	Samantha, 2010
Tapeworms, intestinal worms	CO	Castor oil taken internally has been documented to discharge tape worms successfully. Take a tablespoon of castor oil in a glass of warm milk in the morning and at night. The worms will be passed out of the system	Samantha, 2010
	R	50 gms of root is boiled with 2 cups of water until 1 cup remains. 1 cup is then taken daily for 3 days. This useful for to treat intestinal worms	Ross, 2003
Tumour	L	In Italy the fresh leaves are applied on the breast as a galactagogue and on affected area to treat tumour	Ross, 2003
Weakened immune system	CO	Castor oil has the remarkable ability to increase our body's lymphocytes. Lymphocytes, or white blood cells, regulate wound healing. Studies have shown that T lymphocytes may play an important role in healing. Thus castor oil applications appear to be helpful for anyone weakened immune systems.	Samantha, 2010

**Key:** AP = Aerial parts, L = Leaves, CO = Castor Oil, R = Root, Sd = Seed,

#### **Antimicrobial activity**

Different solvent extracts of *R. communis* roots (200mg/ml) were evaluated for antimicrobial effects. For this purpose well known diffusion method was applied against the diseases causing microorganisms such as *Aspergillus niger*, *Bacillus subtilis*, *Candida albicans*, *E. coli*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *S. aureus* and *Salmonella typhimurium*. The hexane and methanol extracts revealed maximum antimicrobial activity whereas less antimicrobial properties was shown by the aqueous extracts (Jena and Gupta, 2012).

#### **Anti amoebic activity**

A study was carried out to investigate the anti amoebic activity of the different extracts of roots / stem of *R. communis*. The ethanol/water (1:1) extract of the root, in broth culture, at a concentration of 125mcg/ml and similar extract of the stem were active against *Entamoeba histolytica* (Ross, 2003).

#### **Antibacterial activity**

A study was carried out to investigate the different *R. communis* leaf extracts for the antibacterial activity against dermatophytic and pathogenic bacteria, *E. coli*, *K. pneumoneae*, *S. aureus*, *Streptococcus progens*. Disc diffusion method was used for this purpose. All the extracts revealed profound anti bacterial activities. The acetone extracts showed maximum zone of inhibition ( $P < 0.0001$ ).

This study found the latent effectiveness of the selected leaves of *R. communis* as an anti bacterial agent. Still further studies are required to investigate active compounds and probable medicinal application in chemotherapy for human beings (Islam, 2010).

In another work the antibacterial activities of *R. communis*. fermented seed extracts were evaluated. The seeds without seed coats, were ground to make powder, then fermented. After that, extractions with alcohol and water were prepared with the help of Soxhlet machine and were used in different concentrations against special bacteria. For this diffusion method of susceptibility testing on sensitivity testing agar medium was used. *E. coli*, *K. pneumoniae*, *P. vulgaris*, and *S. aureus* showed significant susceptibility to both the above ex tracts whereas *Pseudomonas aeruginosa* was less susceptible. The *Enterococcus faecalis* revealed resistance to all the extracts. In fermented *R. communis* seeds the active antimicrobial compounds should be investigated whereas their therapeutic values should be evaluated properly for human beings (Jombo and Enebeaku, 2008).

#### **Anti- cancer effects**

In the present work the in-vitro anti-cancer effects of the ethanolic extract of *R. communis* against 7 human cancer cell lines were investigated. The seven cell lines were: Colon cancer cell line (Colon HT-29, SW-20, SiHa), Liver cancer cell line (Hep-2), Breast cancer cell line (T-47D), Cervix cancer cell line OVCAR-5, Prostrate cancer cell line (PC-3). The sulforhodamine B (SRB) assay was applied for testing the cytotoxic effect of test material at 100µg/ml concentration against all the cell line. The ethanolic extract of *Ricinus communis* seed revealed 41% activity against Colon 502713 whereas maximum activity was shown by stem part against SiHa (47%) (Prakash and Gupta, 2014)

#### **Anti-implantation activity**

In a work when the ether soluble fraction of methanol extract of *R. communis* var. *minor* was administered subcutaneously to adult female rats and rabbits at a dose

upto 1.2g/kg and 600 mg/kg respectively in divided doses the result revealed anti-implantation, anticonceptive and estrogenic activity in the above tested animals (Rana *et al.*, 2012).

#### **Anti-inflammatory activity**

A study was conducted to evaluate the anti-inflammatory and free radical scavenging activities of the root extract of *R. communis* in Wistar albino rats. The study showed positive results of above extract for the tested activities. The chemical constituents which caused the above activities may be flavonoids, alkaloids and tannins present in the plant (Nath *et al.*, 2010)

#### **Antioxidant activity**

In one study extracts of seed of castor oil plant (*R. communis*) were investigated for the antioxidant activity by using lipid per oxidation by ferric thiocyanate method and free radical scavenging effect on 2,2 diphenyl-1-picrylhydrazyl radical (DPPH) and hydroxyl radical generated from hydrogen peroxide. The results showed high antioxidant activity of *R. communis* seed at low concentration. The phytochemicals constituents responsible for antioxidant activity may be Methyl ricinoleate, Ricinoleic acid, 12 octadecadienoic acid and methyl ester present in *R. communis*. The presence of flavonoids in the extracts of *R. communis* stem and leaves may also produce antioxidant activity (Jena and Gupta, 2012).

#### **Antinociceptive activity**

A study was conducted to investigate the antinociceptive effect of *R. communis* leaves extract against acetic acid induced writhing test, formalin induced paw licking and tail immersion methods in mice. The results revealed that methanolic leaves extract of *R. communis* possessed profound antinociceptive effect against all the above tests in mice. The phytochemicals constituents responsible for antinociceptive activity may be saponins, steroids and alkaloids (Jena and Gupta, 2012).

#### **Bone regeneration activity**

The study was conducted to evaluate the *Ricinus communis* polyurethane for its biocompatibility and its capability of regeneration of bone stimulation. Results revealed that RCP combined with calcium carbonate or calcium phosphate could encourage matrix mineralization and are biocompatible materials. Incorporating alkaline phosphatase to RCP with subsequent incubation in Synthetic body fluid could improve the biological properties of RCP. The advantage seen in RCP as compared to demineralized bone is that the former has a slower reabsorption process (Rana *et al.*, 2012).

#### **Ricinine the central nervous system (CNS) stimulant**

Ricinine which is removed from the castor seed coat extract revealed typical central nervous system stimulant

effect when administered to mice and the results showed an enhanced memory consolidation, decrease in tentative behaviour and catalepsy similar properties (Williamson, 2002).

#### **Free radical scavenging activity**

Study was carried out to investigate *Ricinus communis* extract for free radical scavenging activity. The methanolic extract revealed considerable free radical scavenging activity by inhibiting lipid peroxidation initiated by carbon tetrachloride and ferrous sulphate in rat liver and kidney homogenates. The extract improved free radical scavenging activity of stable radical 2,2-diphenyl-1-picryl-hydrazyl (DPPH), nitric oxide and hydroxyl radical in vitro assay methods (Ilavarasan *et al.*, 2006).

#### **Hepatoprotective activity**

The extract of Castor oil plant leaf was evaluated for hepatoprotective, choleric and anticholestatic effects. The result of an initial trial of an ethanol extract with albino rats, revealed significant safety against galactosamine-induced hepatic damage. It also revealed dose-dependent choleric and anti cholestatic effect, and hepatoprotective activity as judged by hepatocytes isolated from paraceta mol-treated rats. On fractionation of the ethanol extract, maximum activity was localized in the butanol fraction (Visen *et al.*, 1992).

#### **Insecticidal and larvicidal activity**

In study water extract of castor oil plant leaf was evaluated as insecticidal agent. It revealed a significant insecticidal effect against *Callosobruchus chinensis* L (Coleoptera: Bruchidae). In another study flavonoids were isolated and investigated for insecticidal and antimicrobial activities. They revealed effective insecticidal, ovicidal and oviposition prevention activities against *C. chinensis*. But the activity against the common microbial infestants of stored pulses, of which *C. chinensis* is a major pest, was found to be insignificant (Upasani *et al.*, 2003).

Seeds have insecticidal activity against *Spodoptera frugiperda* (Ramos-López *et al.*, 2010) Crude extracts have larvicidal activity against *Anopheles arabiensis* and *Culex quinquefasciatus* (Nath *et al.*, 2011).

#### **Repellent properties**

The taste of the castor oil is terrible so it has been used as a spray to repel moles. Similarly the odour of the castor plants is unpleasant; therefore, they have been used as repellent when planted around the mole infested areas. Care should be taken that children and pets have no access to the poisonous seeds (Grant, 2012).

#### **Ethnomedicinal uses**

Since ancient time the castor oil has been widely used as a curative means in local medicines throughout the world for various diseases such as abdominal disorders, arthritis,

backache, muscle aches, bilharziasis, chronic backache and sciatica, chronic headache, constipation, expulsion of placenta, gallbladder pain, period pain, menstrual cramps, rheumatism, sleeplessness, and insomnia which have been summarized in table 3.

### Toxicity

The toxicity of castor beans (seeds) has been known since ancient times. Castor beans contain ricin (protein) and ricinine (alkaloid), both are very toxic but ricin is relatively more toxic and in small amount it is found in other parts of the plant (Nair, 2009).

Ricin is so effective that 1mg is enough for the killing of an adult person.

Ricin was likely the poison used by a murderer to kill Gyorgi Markov, a Bulgarian rebel living in London in the late 1970's. The toxin was contained in a pellet injected into Markov's leg by a device hidden as an umbrella (O'onnell *et al.*, 2006; Anon., 2007).

Ricin is a slow-acting poison, which causes death after 1-3 days. It destroys protein manufacturing organelles of the cell known as ribosomes.

Ricinine is a toxin belonging to a piperidine alkaloid present in *Ricinus communis* seed and is known as a biomarker for the exposure to ricin.

RCA (*Ricinus communis* agglutinin) is another toxic protein in the castor bean, which clots red blood cells. It means, if RCA is injected in the blood stream of a person the blood is coagulated (Helmenstine, 2001)

### CONCLUSION

*Ricinus communis* (castor plant) is one of the thousands of important medicinal plants used traditionally throughout the world. The pharmacological effects (activities) reported from various sources prove that *R. communis* has much more healing potential. The existence of important chemical compounds in the plant and pharmacological properties confirmed that *R. communis* possesses most important capability for the improvement of novel potent drugs in future.

### REFERENCES

Anonymous (2004). Iстриanet.org. Herbs - Roots - Vegetables Flora. Available at: <http://www.istriianet.org/istria/flora/herbs-roots-vegies/ricinus-communis.htm>

Anonymous (2007). Castor bean In: The Chemistry Encyclopedia. Available at: [http://www.chemistrydaily.com/chemistry/Castor\\_bean](http://www.chemistrydaily.com/chemistry/Castor_bean)

Anonymous (2008). Castor Oil - Remarkable Healing Abilities? Available at: <http://www.squidoo.com/castoroil>.

Aouinty B, Outara S, Mellouki F and Mahari S (2006). Évaluation préliminaire del'¼ activité larvicide des extraits aqueux des feuilles du ricin (*Ricinus communis*

L.) et du bois de thuya (*Tetraclinis articulata* (Vahl) Mast.) sur les larves de quatre moustiques culicidés: *Culex pipiens* (Linné), *Aedes caspius* (Pallas), *Culiseta longiareolata* (Aitken) et *Anopheles maculipennis* (Meigen). *Biotechnol. Agron. Soc. Environ.*, **10**(2): 67-71.

Ayurvedacharya RV (2001). The wonder shrub, Erand. Health Bulletin. Available at: <http://www.tribuneindia.com/2001/20010912/health.htm#5>

Caffarini P, Carrizo P, Pelicano A, Rogggero P and Pacheco J (2008). Effects of acetonic and water extracts of *Ricinus communis*, *Melia azedarach* and *Trichillia glauca* on black common cutting ant (*Acromyrmex lundi*). *IDESIA*, **26**(1): 59-64.

Chen Z, Zhang J and Chen G (2008). Simultaneous determination of flavones and phenolic acids in the leaves of *Ricinus communis* L. by capillary electrophoresis with amperometric detection. *J. Chromatogr.*, **863**(1): 101-106.

Darmanin S, Wismayer PS, Podesta MTC, Micallef MJ and Buhagiar JA (2009). Phytochemistry. An extract from *Ricinus communis* L. leaves possesses cytotoxic properties and induces apoptosis in SK-MEL-28 human melanoma cells. *Natural Product Research*, **23**(6): 561-571.

Elimam AM, Elmalik KH and Ali FS (2009). Larvicidal, adult emergence inhibition and oviposition deterrent effects of foliage extract from *Ricinus communis* L. against *Anopheles arabiensis* and *Culex Quinqüefasciatus* in Sudan. *In: Tropical Biomedicine*, **26**(2): 130-139.

Garcia LFR, Almeida GL, Fernanda CP, Souza PD and Consani S (2009). Antimicrobial activity of a calcium hydroxide and *Ricinus communis* oil paste against microorganisms commonly found in endodontic infections. *Chemical Business*, **24**(8): 50.

Grant B. Castor Beans & Ground Moles. Available at: <http://www.gardenguides.com/131783-castor-beans-ground-moles.html> Accessed on November 5 2012

Helmenstine AM (2001). Ricin and RCA-Castor Bean Toxins. Available at: <http://chemistry.about.com/cs/toxicchemicals/a/aa040403a.htm>

Ilavarasan R, Mallika M and Venkataraman S (2006). Anti-inflammatory and free radical scavenging activity of *Ricinus communis* root extract. *J. Ethnopharmacol.*, **103**(3): 478-480.

Islam T, Bakshi H, Sam S, Sharma E, Hameed B, Rathore B, Gupta A, Ahirwar S and Sharma M (2010). Assessment of antibacterial potential of leaves of *ricinus communis* against pathogenic and dermatophytic bacteria. *Inter. J. Pharm. Resear. Developm.*, **IJPRD**, **1**(12): 1-7.

Jena J and Gupta AK (2012). *Ricinus communis* Linn: A phytopharmacological Review. *Inter. J. Pharm. Pharmaceut. Sci.*, **4**(4): 25-29.

Jombo GTA and Enebeaku MNO (2008). Antibacterial profile of fermented seed extracts of *Ricinus*

- communis*: Findings from a preliminary Analysis. *Niger. J. Physiol. Sci.*, **23**(1-2): 55-59.
- Jombo G and Enenebeaku M (2007). Antimicrobial susceptibility patterns of bacteria to seed extracts of *Ricinus Communis*: Findings of a preliminary study in Nigeria. *The Internet J. Microbio.*, **4**(1): 1-6.
- Leonardo MR, Silva LA, Filho MT, Bonifácio KC and Ito IY (2001). *In vitro* evaluation of the antimicrobial activity of a castor oil-based irrigant. *J. Endod.*, **27**(12): 717-719.
- McGaw LJ, Merwe DV and Eloff JN (2007). *In vitro* anthelmintic, antibacterial and cytotoxic effects of extracts from plants used in South African ethnoveterinary medicine. Open UP. Mushobozy DMK, Nganilevanu G, Ruheza S and Swella GB (2009). Plant oil as common bean (*Phaseolus vulgaris* L.) seed protectants against infestations by the Mexican bean weevil *Zabrotes subfasciatus* (Boh.). *J. Plant Prot. Res.*, **49**(1): 35-39.
- Nair S (2009). Castor Oil Plant. Available at: <http://www.buzzle.com/articles/castor-oil-plant.html>
- Nath S, Choudhury MD, Roychoudhury S, Talukdar AD, Sirotkin AV, Bakova Z, Kadasi A, Maruniakova N and Kolesarova A (2011). Restorative aspect of castor plant on mammalian physiology: A review. *J. Microbiol. Biotechnol. Food Science*, **1**(2): 236-246.
- O'Connell KP, Skowronski EW, Dretchen KL, Leshin JA and Weeks A (2006). Discovery and Characterization of novel signatures from the *Ricinus communis* (Castor bean) genome, pp.1-30.
- Ogunniyi DS (2006) Castor oil: A vital industrial raw material. *Biores. Technol.*, **97**: 1086-1091
- Okwuasaba FK, Das SC, Isichei CO, Ekwonchi MM, Onoruvwe O and Olayinka AO *et al.* (1997). The anticonceptive and the effect on uterus of ether extract, 18312-J of *Ricinus communis*. *Phytother. Res.*, **10**: 97-100.
- Onwuliri VA and Anekwe GE (2001). Amino Acids and other biochemical Components of *Ricinus communis* L. (Variety Minor), an anti-conceptive Seed. *Pak. J. Biol. Sci.*, **4**(7): 866-868.
- Prakash E and Gupta DK (2014). *In vitro* study of extracts of *ricinus communis* Linn on human cancer cell lines. *J. Medic. Sci. Pub. Health*, **2**(1):15-20.
- Rajeshkumar D, Nagachaitanya V, Manasa G, Usharani AMV and Naga K (2013-14). Pharmacological evaluation of analgesic activity of aqueous extract of *ricinus communis* root bark. *Intern. J. Toxicol. Pharmacol. Resear.*, **5**(4): 94-95.
- Ramos-López MA, Pérez GS, Rodríguez-Hernández PC, Fefer G and Sánchez M (2010). Activity of *Ricinus communis* (Euphorbiaceae) against *Spodoptera frugiperda* (Lepidoptera: Noctuidae). *Afri. J. Biotechnol.*, **9**(9): 1359-1365.
- Rana M, Dhamija H, Prashar B and Sharma S (2012). *Ricinus communis* L. A Review. *Int. J. Pharm Tech. Res.*, **4**(4): 1705-1711.
- Ross IA (2001). Medicinal plants of the world: Chemical constituents, traditional and modern medicinal uses, vol. 2, 1<sup>st</sup> edition. Totowa, New Jersey, USA: Humana Press, pp.375-380.
- Ross IA (2003). *Ricinus communis* L. In: Medicinal plants of the world: chemical constituents, traditional, and modern medicinal uses. **2**: 375-393.
- Salhab AS, Shomaf M S, Gharaibeh MN, Amer NA (1999). Effects of castor bean extract and ricin A-chain on ovulation and implantation in rabbits. In *Contraception*, **59**(6): 395-400.
- Salimon J, Noor DAM, Nazrizawati AT, Firdaus MYM and Noraishah A (2010). Fatty acid composition and physicochemical properties of malaysian castor bean *ricinus communis* L. Seed Oil. *Sains Malaysiana*, **39**(5): 761-764.
- Samantha. Castor Oil's many forgotten uses (Part 1- Medicinal) Pharmaceutical Biology. Available at: <http://skinverse.com/castor-oils-many-forgotten-uses-part-1-medicinal-values.html>
- Sandhyakumary K, Bobby RG and Indira M (2003). Antifertility effects of *Ricinus communis* (Linn) on rats. *Phytother. Res.*, **17**(5): 508-511.
- Shokeen P, Anand P, Murali YK and Tandon V (2008). Antidiabetic activity of 50% ethanolic extract of *Ricinus communis* and its purified fractions. *Food and Chemical Toxicology*, **46**(11): 3458-3466.
- Singh PP, Ambika and Chauhan SMS (2009). Activity guided isolation of antioxidants from the leaves of *Ricinus communis* L. *Food Chemistry*, **114**:1069-1072.
- Singh, R and Geetanjali (2015). Phytochemical and Pharmacological Investigations of *Ricinus communis* Linn. *Algerian Journal of Natural Products*, **3**(1): 120-129.
- Smith AR (1986). Euphorbiaceae. In: Nasir E and Ali SI. Flora of Pakistan, Karachi, **172**: 69-71.
- Tinzaara W, Tushemereirwe W, Nankinga CK, Gold CS and Kashajja I (2006). The potential of using botanical insecticides for the control of the banana weevil, *Cosmopolites sordidus* (Coleoptera: Curculionidae). *Afr. J. Biotechnol.*, **5**(20): 1994-1998.
- Tunika. 2008. Conjunctivitis Home Remedy Using Castor Oil. Available at: <http://www.mamaherb.com/conjunctivitis-home-remedy-using-castoroil?ktrack=kcplink>
- Upasani SM, Kotkar HM, Mendki PS and Maheshwari VL (2003). Partial characterization and insecticidal properties of *Ricinus communis* L. foliage flavonoids. *Pest Manag Sci.*, **59**(12):1349-1354.
- Visen PKS, Shukla B, Patnaik GK, Tripathi SC, Kulshreshtha DK, Srimal RC and Dhawan BN (1992). Hepatoprotective activity of *Ricinus communis* leaves. *Pharm. Biol.*, **30**(4): 241-250.
- Williamson EM (2002). In: *Major herbs of ayurveda*, 1st edition. London, UK: Churchill Livingstone, pp.252-254.

- Yuldasheva NK, Ul'Chenko NT and Glushenkova AI (2002). Lipids of *Ricinus communis* Seeds. *Chem. Natur. Comp.*, **38**(5): 413-415.
- Zhang X, Han F, Gao P, Yu D and Liu S (2007). Bioassay-guided fractionation of antifertility components of castorbean (*Ricinus communis* L.) seed extracts. *Nat. Prod. Res.*, **21**(11): 982-989.