Avicenna Journal of Phytomedicine (AJP)

Short-Communication

Clinical and laboratory findings in patients with castor bean (*Ricinus communis* L.) poisoning referred to Imam Reza hospital in northeast of Iran, from April 2015 to March 2020

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Article history:
Received: Oct 23, 2023
Received in revised form: Jul 24, 2024
Accepted: Jul 25, 2024
AJP, Vol. 16, No. 5, Sep-Oct 2026, 811-818.
https://dx.doi.org/10.22038/ajp.2025.26942

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Keywords:
Ricin
Castor Bean
Herbal
Poisoning
Vomiting

Abstract

Objective: Castor bean (CB) (*Ricinus communis)* contains a highly toxic natural compound called ricin. We retrospectively reviewed the documents of CB-poisoned cases referred to the clinical toxicology department of Imam Reza Hospital affiliated with Mashhad University of Medical Sciences, Mashhad, Iran.

Materials and Methods: Patients' data including epidemiological variables, rout and amount of CB ingestion, clinical and laboratory findings, and type of treatment were extracted from hospital documents.

Results: Twelve cases of CB ingestion, with mean age 29.42±21.19 years (4 to 70 years), 4 children (33.3%), and two elderly people (16.7%), were included in the study. All of them were intoxicated by oral ingestion of CB. The mean number of ingested CBs was 4.83±3.16 seeds (range 1-10, median 5 seeds). The most common complaint of the cases (n=11, 91.67%) was frequent vomiting, followed by nausea (n=7, 41.7%) and diarrhea (n=4, 33.3%). Vomiting more commonly occurred up to the second hour after seeds ingestion and at a frequency of 8 to 21 times. The vital signs of all cases were in normal ranges and no tachycardia, hypotension, or tachypnea was recorded. Also, all laboratory results were normal, except metabolic acidosis (pH 7.3) in one case (8.3%). All cases were discharged in good condition with conservative treatment after 19.5±15.3 hr (12-45 hr, median=22 hr). None of them reported any problem in follow-up.

Conclusion: The majority of our cases were mild. Gastrointestinal problems, especially frequent vomiting, were the most common complaints. Conservative management was effective in mild to moderate cases.

Please cite this paper as:
Moshiri M, Ramazani Y, Akhgari N, Dadpour B, Etemad L. Clinical and laboratory findings in patients with castor bean (*Ricinus communis* L.) poisoning referred to Imam Reza hospital in northeast of Iran, from April 2015 to March 2020. Avicenna J Phytomed, 2026; 16(5): 811-818.

Introduction

Ricinus communis (Castor) is an evergreen herbaceous or semi-woody large shrub or small tree. It is widespread throughout tropical and subtropical areas around the world. The high similarity of Castor bean (CB) to edible beans leads to CB intoxication. It was reported that 1-5% of the weight of CB is ricin toxin (RT), that is a highly toxic substance (Moshiri et al. 2016). RT is a water-soluble heat-stable glycoprotein (Worbs et al. 2011) that is stable under ambient conditions (Centers for Disease Control and Prevention 2018). RT can be absorbed and cause poisoning through oral, inhalation, injection, and eye contact (Balali-Mood et al. 2013).

RT has two chains called A and B. The B chain binds to the cell surface and helps the A chain to enter the cell. The A chain inhibits the protein synthesis inside the cell. One molecule of RT can deactivate 2000 ribosomes every minute, and leads the cells to death (Doan 2004).

However, CB intoxication is not common, and it could be severe or even lethal. In patients who ingest CB, abdominal pain, pharynx and larynx irritation, vomiting, and diarrhea are the initial symptoms of poisoning. Ingestion of RT can also cause various types of gastrointestinal bleeding such as hematoma, melena, and hematochezia due to necrosis of the disturbed parts of the digestive tract. Necrosis also occurs in the liver, spleen, and kidneys (Balali-Mood et al. 2013; Moshiri et al. 2013; Olsnes and Kozlov 2001). Other serious complications of CB ingestion include dehydration, hypotension, tachycardia, cyanosis, hypovolemic shock, kidney failure, acute vascular leakage syndrome, hypoglycemia, and hemolysis.

We retrospectively reviewed the documents of CB-poisoned cases who were referred to the clinical toxicology department of Imam Reza Hospital affiliated with Mashhad University of Medical Sciences, Mashhad, Iran (CTD-IRH-MUMS).

Materials and Methods

This research presents a retrospective cross-sectional study from April 2015 to March 2020 and was designed to review the reported cases with a diagnosis of CB ingestion who were referred to CTD-IRH-MUMS. Documents were selected according to ICD-10 codes that were recorded by the hospital information system based on the confirmed diagnosis of patients by physicians at discharge. The final diagnosis was performed according to the patients' history taken from themselves, their family or friends, and the clinical suggestion of physicians. No toxicology laboratory tests were carried out for diagnosis. All documents with incomplete data (more than 50% of variables) were excluded.

A checklist was used to collect data. Data of all patients, such as epidemiological, rout and amount of CB ingestion, clinical and laboratory findings, type of treatment, outcome, and length of hospital stay were extracted from documents by maintaining individual privacy and confidentiality. The patients' data were coded and registered. This study was approved by ethical committee of MUMS (IR.MUMS.MEDICAL.REC.1398.726).

Statistical analysis

Statistical analysis was performed with the IBM SPSS software version.16. Quantitative variables are reported as Mean±SD and qualitative variables are reported in percentage frequency. The means of age of two sexes was compared by impaired T test. The means of vital signs in various times of hospitalization were compared by ANOVA. A p-value of lower than 0.05 was considered significant.

Results

Twelve cases of CB ingestion were referred to CTD-IRH-MUMS from April 2015 to March 2020. The mean age was 29.42±21.19 years (4 to 70 years) and 6 cases (50%) were male (Tables 1 and 2).

More than half of the patients (7 cases, 58.3%) were married. There were four children (33.3%) and two elderly (16.7%). The most of the cases lived in the city. All of the cases were intoxicated through oral ingestion of CB. The mean number of ingested CBs was 4.83±3.16 (range 1-10, median 5 seeds) and two cases ingested 10. Seven cases were members of a family that fried the CBs and then chewed thoroughly and tasted them. Four patients (33%) chewed completely raw castor seeds. The exact type of ingestion in one case was not defined. Although 9 patients (83.3%) accidentally consumed CBs, two cases (16.7%) had consumed them out of curiosity (30 and 40-year-old women). There were no suicidal or self-harm attempts.

The most common complaint of the patients was frequent vomiting (11 cases, 91.67%) followed by nausea (5 cases, 41.7%). Some of them vomited 8 to 21 times despite antiemetic treatment. Vomiting more commonly occurred between the first and the second hours after seed swallowing. Four cases (33.3%) experienced diarrhea as well. Bloating and abdominal pain was reported only in one case (Table 2).

Table 1. The means of age (year) in both sexes of caster been intoxicated patients referred to CTD-IRH-MUMS during 2015 – 2020

sex	Number (%)	Mean ±SD	Median (Min- Max)	p-value
Men	6 (50.0%)	21.17±25.19	20.5 (4-70)	0.432
Women	6 (50.0%)	31.60±18.49	34.5 (8-60)	
Total	12 (100.0%)	29.42±21.19	31 (4-70)	

Table 2. Demographic and the main complaints of caster bean intoxicated patients referred to CTD-IRH-MUMS during 2015 – 2020

Case number	Age (year)	gender	marital status	Place of residence	The main complaints	Number of ingested seeds	Lag time* (hours)
1	15	male	single	City	Frequent vomiting (>10 times)	10	9
2	38	male	married	City	Vomiting (8 times) Nausea	Not reported	9
3	37	male	married	City	Frequent vomiting(>10 times)	10	9
4	60	male	married	City	watery diarrhea Frequent vomiting (>10 times)	6	5
5	11	female	single	City	Frequent vomiting	2	5
6	8	female	single	City	Flatulence	5	7
7	8	male	single	City	Vomiting	3	7
8	70	female	married	City	Frequent vomiting (>10 times)	7	9
9	4	female	single	City	watery diarrhea Frequent vomiting (>10 times) Lethargy	Unknown	8
10	40	female	married	Village	Frequent vomiting	1	3
11	30	female	married	City	Frequent vomiting Diarrhea Abdominal pain	1	9
12	32	male	married	City	Abdominal pain Frequent vomiting (>10 times) Anorexia	5	Not reported

*Lag time between ingestion of caster been and hospitalization

The results of liver and kidney function tests, coagulation tests, and electrolyte levels were in age- and sex-related reference ranges (Tables 3 and 4). Only one case (8.3%) had a transient mild metabolic acidosis of unknown etiology (pH 7.3). The blood cell counts of all patients were within the normal range (Table 3).

The means of vital signs of adult cases at admission were as follows: heart rate 88.87±9.92 beats/ minute, blood pressure 117.86±16.30/74.28±7.87 mmHg, respiratory rate 16.71±1.25 cycles/minute and body temperature 37.10±0.30°C (Table 5). There was no significant difference between the vital signs of adult patients during their hospitalization. In children, the vital signs were within normal limits. There were no cases of tachycardia, hypotension, or tachypnea according to the age of the patients. No loss of consciousness was recorded at admission or during hospitalization, except for one case who was lethargic at admission and became alert a few hours later. All patients were treated conservatively with electrolyte solutions and antiemetic medicine (metoclopramide and/or ondansetron). Half of the cases received activated charcoal, however, others could not tolerate charcoal due the frequent vomiting. None of the cases were decontaminated by gastric lavage, because of hospitalization more than one hour after ingestion or the large volume and repeated vomiting before admission. Due to the lack of a single approved protocol at that period, some suggested treatments were performed by different physicians. They included dexamethasone (7 cases, 58.3%), vitamin C (6 cases, 50%), and N-acetyl cysteine (n=3 cases, 25%). There was no difference in the prognoses of all cases. No mortality or disability was reported. All the cases were discharged after 19.5±15.3 hr (12-45 hr, median=22 hr) in good condition. None of them reported any problem in follow-up.

Table 3. The results of blood sugar, serum electrolytes, blood gas levels, hematologic indexes, and creatinine phosphokinase serum level of patients (at admission) who ingested caster bean and referred to CTD-IRH-MUMS during 2015 – 2020

Case number	Na (mmol/l)	K (mmol/l)	Ca (mmol/l)	pH	PCO2 (mmHg)	HCO3 (meq/l)	CPK mcg/L	BS (mg/dl)	WBC (×10^3 µl)	Hb (g/dl)	Plt (×10^3 µl)
1	138	3.9		7.36	42	21.2		110	5.8	14.2	185
2	143	3.7		7.35	40	20.4	216	89	6.8	13.8	234
3	141	4.2		7.42	41	26.1		98	7.4	15.3	246
4	137	3.7		7.41	36	21.2		124			
5*	140	3.6	9.5	7.44	30.2	20.5	173	105	8.5	13.7	228
6*	141	3.6	9.7	7.46	28.4	20.4		91	7.1	13	289
7*	139	4	10.2	7.36	45.6	25.8	227	110	9.2	14	340
8	135	4.1		7.35	34	21.3		118			
9*	138	3.9	9.9	7.3	37.7	18.8	91	111	9.5	12.5	251
10	138	3.8		7.36	48.1	27.5	112	141	9.8	12.4	272
11	137	3.7		7.32	56.3	29.1	84	97	6	12.6	238
12	143	5.4		--	--	--	112	134	8.4	14.3	287

BS= Blood sugar, Ca=calcium, CPK= creatinine phosphokinase, Hb=Hemoglobin, K=potassium, NA= sodium, Plt=Platelet, WBC= White Blood Count, *=child

Table 3. The liver and kidney function and coagulation tests results of patients who ingested caster bean and referred to CTD-IRH-MUMS during 2015 – 2020

Case number	AST (U/L)			ALT (U/L)			ALP (U/L)			Bili T (mg/dl)			Bili D (mg/dl)			PT (s)		PTT(s)		INR		CR (ml/dl)		Urea (ml/dl)	
	At Admission	6 hr latter	18 hr latter	At admission	6 hr latter	18 hr latter	At admission	6 hr latter	18 hr latter	At admission	6 hr latter	18 hr latter	At admission	6 hr latter	18 hr latter	At Admission	6 hr latter	At admission	6 hr latter	At admission	6 hr latter	At Admission	6 hr latter	At admission	6 hr latter
1	19	18	15	16	17	12	547	486	435	0.9	0.6	0.4	0.2	0.2	0.2	15.7		24		1.44		0.9	0.9	16	20
2	22	19	17	16	16	16	239	186	192	1.2	1.1	1.9	0.3	0.3	0.5	14.4		25		1.26		1.4	1.2	32	30
3	19	16	13	26	25	21	199	157	158	1.1	0.9		0.2	0.2		14.7		33		1.3		1.3	1.2	34	33
4	19	19	24	17	17	18	152	123	117	1.3	1.1	1.7	0.3	0.3	0.5	14.9		25		1.33		1.5	1.2	35	31
5*	24	30		10	9		848				0.8			0.2		15.8	12.5	31	31	1.46	1	0.8			
6*	28	29		12	11		750	620		0.8			0.2			15.0	13	31	27	1.34	1.07	0.6			
7*	27	28		13	14		870	703			0.6			0.2		15.o	12.5	28	33	1.34	1	0.7			
8	13	16	15	14	17	13	142	140	155	0.8	0.6	0.6	0.1	0.2	0.2	14.7		31		1.3		1.1	0.9	24	17
9*	29	42	39	13	11	24	454	288			0.5			0.2		15.0	11.5	25	27	1.34	0.87	0.6			
10	27			35			142									11.8		28.9		0.97		0.8			
11	14			7			134									13.4		34		1.2		0.7			
12	37			45			180															0.9			

ALP= Alkaline phosphatase, ALT= Alanine transaminase, AST = Aspartate transaminase, Bili,D=Bilirubin direct, Bili T= Bilirubin total, CR= Creatinine, INR= international normalized ratio, PT= Prothrombin time, PTT= partial thromboplastin time, *=child

Table 5. Recorded vital signs of caster bean intoxicated patients referred to CTD-IRH-MUMS during 2015 – 2020

Case number	Heart rate (beats/ min)					Blood pressure (mm Hg)					Temperature (°C)					Respiratory rate (cycles /min)				
	At admission	1 hr latter	6 hr latter	12 hr latter	18 hr latter	At admission	1 hr latter	6 hr latter	12 hr latter	18 hr latter	At admission	1 hr latter	6 hr latter	12 hr latter	18 hr latter	At admission	1 hr latter	6 hr latter	12 hr latter	18 hr latter
1	81	88	96	84	78	110.70	105.75	110.70	110.60	105.60	37.7	37.3	36.4	36.4	36.4	17	15	16	18	15
2	88	82	78	93	87	100/70	100/60	120/80	110/60	115/70	37.0	37.1	37.0	37.1	37.2	17	15	16	14	17
3	88	96	84	83	91	110/70	110/70	110/70	115/80	110/60	37.0	36.4	37.1	37.2	37.1	17	16	17	17	18
4	88	93	84	85	67	110/70	120/80	110/60	110/60	115/65	37.0	36.5	37.1	37.2	36.5	16	15	15	14	15
5*	98	94	95	85	80	100/60	105/60	105/60	110/60	110/60	37.0	37.1	37.0	37.1	37.2	26	27	24	23	23
6 *	96	98	98	---	---	105/60	105/60	107/55	----	----	36.0	36.5	37.0	----	----	20	22	25	---	---
7*	94	96	98	---	---	100/65	105/65	105/60	----	----	37.0	37.2	37.1	----	----	22	24	20	---	---
8	81	89	84	80	88	125/70	130/80	130/60	105/70	120/70	37.0	37.1	36.5	36.5	36.5	15	15	18	15	17
9*	120	103	95	120	95	100/60	90/60	105/75	100/70	100/75	37.0	37.0	37.1	37.2	37.1	22	25	21	25	22
10	84	80	80	76	78	100/68	100/70	100/60	105/65	100/60	37.1	37.0	37.1	37.1	37.0	16	17	14	16	17
11	110	119	109	112	---	150/90	130/92	135/88	130/92	----	37.0	36.8	37.0	37.1	----	16	19	20	18	---
12	80	86	88	76	---	120/80	110/80	114/78	112/82	----	36.9	37.0	37.1	37.1	----	19	18	18	19	---

*=child

Discussion

In this study, 12 cases were referred to CTD-IRH-MUMS with the diagnosis of CB poisoning due to oral ingestion of the seeds. Half of them were male. The most common complaint of the patients was frequent vomiting. There was no significant difference in the vital signs of adult patients at different hours of hospitalization. In children, the vital signs were within the normal range. There were no cases of tachycardia, hypotension, or tachypnea based on their age. There was no case of suicide or self-harm. Also, most of the patients were cured with supportive care and discharged in good condition. There was no difference in the prognoses of all cases with different treatment protocols.

Ricin toxin is one of the most fatal natural toxins that induces cell death via protein synthesis inhibition (Moshiri et al. 2015; Moshiri et al. 2016). Accidental poisoning with ricin has been reported predominantly due to easy access to castor seeds (Olsnes and Kozlov 2001).

Ricin poisoning manifestations can differ depend on the exposure route. The initial symptoms of ricin toxicity are non-specific and can include abdominal pain, diarrhea, nausea, vomiting, heartburn, mydriasis, muscle cramps, anuria, fever, thirst, electrolyte imbalance, hypotension, and circulatory failure (Etemad et al. 2024; Olsnes and Kozlov 2001). In the current study, the most common clinical manifestation was frequent vomiting in the early stages. Melissa Abbes et al. (Melissa Abbes 2021) reviewed the data of 50 cases available all around the world from 1980 to 2020. In line with our findings, the most common clinical presentation was acute gastroenteritis (nausea, vomiting, diarrhea, and abdominal pain).

According to one study in Isfahan, Iran, the age of individuals exposed to ricin toxin was between 20-39 years which was also similar to our results (29.42±21.19 years, median 31 years) and it may be related to the culture of Asian countries in the use of medicinal plants (Gheshlaghi et al. 2022). However, in other studies, ricin poisoning was more common in children due to their curiosity (Krenzelok 1995). In the current study, 33.3% of cases were children.

The oral lethal dose 50 (LD50) of ricin in humans has been estimated at 20 mg/kg of body weight (approximately 8 CBs) (Moshiri et al. 2016). Because of variations in the size, weight, moisture percentage of the seeds, the season, and the age of the plant, the seeds have different amounts of ricin and therefore the estimated dose of ricin in each seed is not accurate (Musshoff and Madea 2009). Also, due to the hardcover of seeds, the amount of released poison is related to the level of chewing (Moshiri et al. 2013). The number of consumed seeds reported in the documents (mild to lethal) ranges from 1.5 to 30 seeds. The lowest number of seeds associated with human death was two seeds (Olsnes 2004; Olsnes and Kozlov 2001; Pincus et al. 2011). In the present study, most of the patients had shown mild poisoning and two cases that had eaten 10 castor seeds presented severe digestive symptoms without other symptoms of poisoning.

Thornton and his colleagues (2014) in a retrospective study evaluated 84 castor seed poisoned patients from 2001 to 2011. All of them were orally intoxicated and only one of them had liver transaminases higher than the normal range (Thornton et al. 2014). In the present study, liver and kidney function tests, electrolytes level, and blood cell count were reported within normal limits. Only one case had a brief reversible metabolic acidosis. However, another study reported a two-year-old girl with hypokalemia, metabolic acidosis, and elevated lipase about four hours after consumption of unspecified amounts of castor seeds (Benamor et al. 2020).

Coagulation disorders were not reported in any of our patients. Hemolysis happened only secondary to parenteral administration of CB. Ricinus communis agglutinin is a glycoprotein of CB that has affinity for the red blood cell and induces red blood cell agglutination and subsequent

hemolysis. However, it is not significantly absorbed from the gastrointestinal (Despott and Cachia 2004).Unfortunately, none of the cases were evaluated for hemolysis later.

In 2012, a 42-year-old Saudi man ingested an herbal medicine mixture containing CB powder. The patient presented in the hospital with gastrointestinal complications and a severe decrease in blood pressure, and he died due to shock and respiratory failure (Assiri 2012). In a case report from Malta, a 70-year-old man went to the hospital with complaints of gastroenteritis, tachycardia, and low blood pressure after eating 10 CBs by mistake. He was discharged with good general condition after 7 days of conservative management (Despott and Cachia 2004). No mortality was found in our study. We did not also have any case of shock or severe hypotension.

Although the average time of death depends on the severity and the route of poisoning, it has been reported to occur between 36-72 hr after toxin entry into the body (Centers for Disease Control and Prevention 2018; Olsnes and Kozlov 2001; Pincus et al. 2011). However, no death was reported in our study and patients were discharged almost after 19 hr of hospitalization with full recovery. Premature discharge of our patients might be related to the lack of an approved protocol at that period (Moshiri and Balali-Mood 2018).

However, there are some cases of severe or lethal RT poisoning secondary to CB ingestion (Assiri 2012; Challoner and McCarron 1990; Despott and Cachia 2004), the majority of reported cases, similar to our results, were mildly intoxicated (Audi et al. 2005; Benamor et al. 2020; Challoner and McCarron 1990; Gheshlaghi et al. 2022; Plenert et al. 2012; Thornton et al. 2014; Wedin et al. 1986). It seems the lack of oral bioavailability of RT results in low risk of severe RT toxicity in oral ingestion of CB. RT is probably destroyed by stomach acid and because of its large size, has little absorption. In addition, in oral consumption, the effect of the RT is reduced due to the high affinity to the carbohydrate molecules (galactose) that is available in food or secreted by the mucous membrane of the digestive system, (Balali-Mood et al. 2013).

Several different compounds were suggested for the treatment of RT poisoning; such as difluoromethylornithine, dexamethasone, and antioxidants (Balali-Mood et al. 2013; Moshiri and Balali-Mood 2018; Moshiri et al. 2013; Moshiri et al. 2016) . However, none of them is a specific antidote and, as the result of current study, prompt treatment with supportive care can decrease the morbidity and mortality rate (Melissa Abbes 2021).

In conclusion, however, CB-poisoning could be lethal; in the majority of the cases it was mild. Gastrointestinal complaints, especially frequent vomiting, were the most common complaints. Conservative management was effective in mild to moderate cases.

Acknowledgment

The data reported in this article are part of an M.D. thesis. We would also like to thank the staff of CTD-IRH-MUMS for their warm cooperation, and the Clinical Research Development Unit, Imam Reza Hospital, Mashhad University of Medical Sciences, for their assistance in this manuscript

Conflicts of interest

None declared.

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