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BIO-EFFICACY OF DIFFERENT DOSES OF CASTOR OIL AS SEED PROTECTANTS AGAINST LESSER GRAIN BORER, *Rhyzopertha dominica* (Fab.) INFESTING STORED WHEAT

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ABSTRACT

Investigations on "Bio-efficacy of different doses of castor oil as seed protectants against lesser grain borer, *Rhyzopertha dominica* (Fab.) infesting stored wheat" were carried out at the Regional Research Station, Anand Agricultural University, Anand in 2025-26. Among different doses of castor oil, castor oil at 34.5 mL per 2.3 kg seeds and castor oil at 28.75 mL per 2.3 kg seeds recorded lower adult population of *R. dominica*, whereas higher population growth observed in castor oil at 11.5 mL per 2.3 kg seeds. Castor oil at 34.5 mL per 2.3 kg seeds recorded higher germination percentage after 6 months of storage as compared to castor oil at 28.75 mL per 2.3 kg seeds and castor oil at 23.00 mL per 2.3 kg seeds. Based on periodical adult mortality, higher adult mortality of *R. dominica* was recorded in castor oil at 34.5 mL per 2.3 kg seeds followed by castor oil at 28.75 mL per 2.3 kg seeds. Castor oil at 23.00 mL per 2.3 kg seeds and castor oil at 17.25 mL per 2.3 kg seeds were found next best treatments, whereas castor oil at 11.5 mL per 2.3 kg seeds was found least effective as it recorded lower adult mortality.

***Keywords* :** Different doses of castor oil, Lesser grain borer, *Rhyzopertha dominica* (Fab.).

Introduction

Wheat is believed to be originated from South West Asia. It is a major crop of the America, Canada, Europe and Asia. Globally, during the 2024-25 cropping season, the total area under wheat cultivation was estimated at 219.51 million ha, with a production of approximately 798.48 million metric tonnes and an average productivity was 3,637 kg/ha (Anonymous, 2024a). In the year 2024-25, India cultivated wheat over an estimated 32.80 million hectares, producing approximately 117.94 million tonnes with an average productivity of 3,595 kg/ha. It ranks third in area and second in production among the cereals grown in India. The most important wheat producing states of India are Uttar Pradesh (36.65 MT), Madhya pradesh (24.51 MT), Punjab (17.99 MT), Haryana (11.40 MT), Rajasthan (11.27 MT), Maharashtra (2.29 MT), Bihar (7.19 MT) and Gujarat (3.87 MT) (Anonymous, 2024b).

Stored wheat is commonly affected by a range of insect-pests, including the lesser grain borer, *Rhyzopertha dominica* (Fabricius), rice weevil, *Sitophilus oryzae* (Linnaeus), red rust flour beetle, *Tribolium castaneum* (Herbst), granary weevil, *Sitophilus granarius* (Linnaeus), maize weevil, *Sitophilus zeamais* (Motschulsky), angoumois grain moth, *Sitotroga cerealella* (Olivier) and rice moth, *Corcyra cephalonica* (Stainton) (Ileke and Oni, 2011). Among these stored grain pests, the lesser grain borer (*R. dominica*) is an important internal and primary feeder. Incidence of lesser grain borer, *R. dominica* occurs both in the field and during storage, which causes significant economic damage during storage (Adedire, 2001). It is a small, highly destructive insect, measuring 2 to 3 mm in length. It has a blackish-brown coloration and belongs to the same family as some wood-boring beetles. Its distinctive bullet-shaped, slim and cylindrical body makes it easy to identify. The head is tucked beneath the thorax and is covered by a rounded, hood-like pronotum marked with pits that gradually decrease in size toward the back. Its antennae are 10 segmented with the last three segments forming a loosely clubbed structure (Mason and McDonough, 2012).

Castor oil is a vegetable oil obtained by pressing the seeds of the castor oil plant, *Ricinus communis* L. mainly cultivated in India, South America, Africa and China. Castor oil consist of 4 per cent linoleic acid, 3 per cent oleic acid, 1 per cent stearic acid and less than 1 per cent linolenic fatty acids. Castor oil does not contain ricin, which is a natural poison found in the castor oil plant, the toxic ricin remains in seed cake following oil isolation. (National Center for Biotechnology Information, 2025). Smearing or mixing of oils and powders is easy, cheap and safe method to protect grains like wheat, milled rice and pulses stored particularly for domestic consumption and it is a traditional Indian practice in rural and urban area. Several studies in last five years have suggested the use of botanicals to control insects in stored grains.

Materials and Methods

An experiment on "Bio-efficacy of different doses of castor oil as seed protectants against lesser grain borer, *R. dominica* (Fab.) infesting stored wheat" was carried out at Seed Laboratory, Regional Research Station, AAU, Anand in July-2025 to January-2026. The effect of different doses of castor oil against lesser grain borer was tested under laboratory condition.

Maintenance of culture of lesser grain borer, *Rhyzopertha dominica*

For initiation of culture, required number of adults were collected from local market of Anand. Adults of lesser grain borer, *R. dominica* were introduced in plastic jar containing 1 kg wheat grains previously sterilized at 55˚C temperature for 4 hours in oven. The plastic jar (diameter: 10 cm, height: 15 cm) was covered tightly with muslin cloth affixed with rubber band to prevent the adults from escaping. The adults of *R. dominica* were reared and maintained in the laboratory for growth and development of the population on wheat grains. The damaged grains were replaced with undamaged and sterilized grain in each jar at monthly interval. The culture was maintained in the laboratory throughout the experimental period.

Application of castor oil

Castor oil was procured from the market. For one treatment required 2.3 kg wheat seeds. So, for each treatment 2.3 kg wheat seeds were poured in plastic jar (diameter: 15 cm, height: 25 cm) and measured quantity of oil was added. Plastic jar was rotated in order to obtain uniform smearing of oil on the seeds (figure 1). The plastic jar was covered with lid and stored in the laboratory for experimental purpose. The grains without oil treatment were kept as control.

Observation Recorded
Population Growth

To evaluate different doses of castor oil as seed protectants, three samples of treated wheat grains each of 50 g from each treatment (one sample for one repetition) were filled in plastic jar (diameter: 5.5 cm, height: 9.5 cm) individually. Five pairs of *R. dominica* adults (5 days old) was released into each jar for egg laying and each jar was covered with two-fold muslin cloth. The adult introduced for oviposition was discarded from each jar after 7 days of oviposition. The data on number of adults (live) developed were recorded monthly during six months of storage and were analyzed using ANOVA after square root transformation.

Adult mortality

To evaluate the efficacy of different doses of castor oil against *R. dominica* based on periodical mortality of adults, a series of experiments was carried out at 15 days' interval. For the purpose, three samples of treated wheat grains each of 50 g (one sample for each repetition) was drawn from each bulk of treatment. The sample was filled in plastic jar (diameter: 5.5 cm, height: 9.5 cm) individually. Ten adults (5 days old) of *R. dominica* obtain from laboratory culture was released into each plastic jar were covered with a piece of two-fold muslin cloth which was held in position with rubber band. The observations on the number of dead adults out of total adults were recorded after 7 days of adult's release and per cent mortality was worked out. Insect showing movement of legs or antennae was considered alive. The periodical data on per cent adult mortality was corrected using Abbott's formula (Abbott, 1925) and analyzed using ANOVA after arc sine transformation

$$P = \frac{P_1 - C}{100 - C} \times 100$$

Where,

P= Corrected mortality (%)

P_1= Observed mortality (%) of the test insect in insecticidal treatments

C= Observed mortality (%) in control treatment

Germination (%)

To assessed the effect of different doses of castor oil on the viability of grains, a laboratory germination test was conducted as per ISTA procedure by adopting 'between the paper method' (International Seed Testing Association, 2015). A hundred seeds in three repetitions were taken at random from treated seeds of each treatment and was placed uniformly on germination paper. The seed roll was kept in germinator at 20 ± 0.50℃ and 95 ± 1 per cent relative humidity. The final count for normal seedlings was caried out on eight day of germination test and was expressed in percentage. The germination percentage was calculated for each treatment based on the data on germination before and after 6 months of storage infestation. The data on germination percentage were subjected to ANOVA after arc sine transformation

Results and Discussions

Population Growth

The efficacy of different doses of castor oil as seed protectants against *R. dominica* was evaluated based on adult population growth during six months of storage and the results are presented in Table 1. The data revealed that all doses of castor oil significantly suppressed population growth of *R. dominica* throughout the storage period. The effectiveness of castor oil increased with increasing dose levels.

At 30 days after storage, no adult emergence was observed in all castor oil treatment. This indicated complete suppression of population development during the initial storage period by all doses of castor oil. At 60 days of storage, the lowest population growth was recorded in castor oil at 28.75 mL per 2.3 kg seeds and 34.5 mL per 2.3 kg seeds, where no adult emergence was observed. These treatments were significantly superior to the lower doses. Castor oil at 23.00 mL per 2.3 kg seeds recorded only 2.31 adults, followed by castor oil at 17.25 mL per 2.3 kg seeds (3.32 adults) and castor oil at 11.5 mL per 2.3 kg seeds (5.66 adults). At 90 and 120 days of storage, castor oil at 34.5 mL per 2.3 kg seeds proved most effective by recording only 1.31 and 3.96 adults, respectively, followed by castor oil at 28.75 mL per 2.3 kg seeds with 1.64 and 5.32 adults, respectively. A gradual increase in population growth was observed in all treatments with advancement of storage period however, the increase was considerably lower in higher doses of castor oil. At 150 days, castor oil at 34.5 mL per 2.3 kg seeds recorded only 9.94 adults, followed by 28.75 mL per 2.3 kg seeds (11.95 adults). Similarly, at 180 days, the lowest population growth was observed in castor oil at 34.5 mL per 2.3 kg seeds (18.61 adults), which was followed by castor oil at 28.75 mL per 2.3 kg seeds (21.61 adults). Overall, the results clearly demonstrated a dose-dependent effect of castor oil on population suppression of *R. dominica*. Among the tested doses, castor oil at 34.5 mL per 2.3 kg seeds proved to be the most effective treatment, followed by 28.75 mL per 2.3 kg seeds. The superior performance of higher doses may be attributed to the formation of a protective coating on seed surfaces, which interferes with oviposition, respiration and development of the insect, thereby restricting population build-up. The reduction in population build-up may be attributed to several modes of action of plant oils.

Further, Shaaya *et al.* (1997) emphasized that botanical oils possess repellent and toxic properties that disrupt feeding and reproductive behaviour of storage insects. The gradual increase in population observed over time, even in treated grains, may be due to partial degradation or reduced persistence of oil coating during long storage periods. These finding agree with Khaire *et al.* (1992), Abdallah *et al.* (2001), Kumawat and Naga (2013). Higher doses, particularly 34.5 mL per 2.3 kg seeds and 28.75 mL per 2.3 kg seeds, were effective in maintaining pest population throughout the storage period.

Table 1: Effect of different doses of castor oil as seed protectants against *R. dominica* based on population growth.

Tr. No.	Treatments	Number of adults emerged after indicated days of storage					
		30	60	90	120	150	180
T_1	Castor oil at 11.5 mL/2.3 kg seeds	0.71 (0.00)	2.48 (5.66)	3.29 (10.33)	4.81 (22.65)	7.27 (52.28)	10.14 (102.31)
T_2	Castor oil at 17.25 mL/2.3 kg seeds	0.71 (0.00)	1.95 (3.32)	2.55 (6.00)	3.98 (15.33)	6.09 (36.64)	9.14 (83.05)
T_3	Castor oil at 23.00 mL/2.3 kg seeds	0.71 (0.00)	1.68 (2.31)	2.41 (5.32)	3.81 (13.99)	5.31 (27.65)	8.73 (75.63)
T_4	Castor oil at 28.75 mL/2.3 kg seeds	0.71 (0.00)	0.71 (0.00)	1.46 (1.64)	2.41 (5.32)	3.53 (11.95)	4.70 (21.61)

T_5	Castor oil at 34.5 mL/2.3 kg seeds	0.71 (0.00)	0.71 (0.00)	1.34 (1.31)	2.11 (3.96)	3.23 (9.94)	4.37 (18.61)
T_6	Control	3.67 (12.99)	6.39 (40.32)	9.19 (83.99)	11.84 (139.63)	13.66 (185.97)	17.11 (292.33)
S. Em. ±		0.03	0.07	0.08	0.10	0.14	0.20
C.D. at 5%		0.10	0.20	0.26	0.30	0.43	0.61
C.V. (%)		4.63	4.88	4.31	3.51	3.74	3.80

Note: Figures in parenthesis are retransformed values, those outside are $\left(\sqrt{x+0.5}\right)$ transformed values

Table 2: Effect of different doses of castor oil as seed protectants based on periodical adult mortality of *R. dominica* during storage of wheat

Tr. No.	Treatments	Corrected mortality (%) after indicated days of storage					
		15	30	45	60	75	90
T_1	Castor oil at 11.5 mL/2.3 kg seeds	71.54 (89.97)	63.41 (79.97)	61.20 (76.79)	54.08 (65.58)	50.75 (59.97)	44.98 (49.97)
T_2	Castor oil at 17.25 mL/2.3 kg seeds	77.41 (95.25)	71.54 (89.97)	63.41 (79.97)	56.08 (68.86)	54.76 (66.71)	50.75 (59.97)
T_3	Castor oil at 23.00 mL/2.3 kg seeds	89.15 (99.98)	71.54 (89.97)	66.12 (83.61)	62.89 (79.23)	56.77 (69.97)	54.76 (66.71)
T_4	Castor oil at 28.75 mL/2.3 kg seeds	89.15 (99.98)	83.28 (98.63)	68.83 (86.96)	65.60 (82.93)	63.41 (79.97)	58.98 (73.44)
T_5	Castor oil at 34.5 mL/2.3 kg seeds	89.15 (99.98)	89.15 (99.98)	71.54 (89.97)	68.31 (86.34)	66.12 (83.61)	63.41 (79.97)
S. Em. ±		2.40	1.13	1.81	1.97	1.38	1.67
C.D. at 5%		7.39	3.47	5.57	6.07	4.24	5.13
C.V. (%)		5.97	5.57	5.65	6.65	4.89	4.63

Note: *Figures in parenthesis are retransformed values, those outside are arc sin transformed values

Table 2: Continue..

Tr. No.	Treatments	Corrected mortality (%) after indicated days of storage					
		105	120	135	150	165	180
T_1	Castor oil at 11.5 mL/2.3 kg seeds	39.22 (39.98)*	33.20 (29.98)	33.20 (29.98)	31.50 (27.30)	26.55 (19.98)	26.55 (19.98)
T_2	Castor oil at 17.25 mL/2.3 kg seeds	46.90 (53.31)	43.06 (46.62)	39.22 (39.98)	37.89 (37.72)	33.20 (29.98)	26.55 (19.98)
T_3	Castor oil at 23.00 mL/2.3 kg seeds	50.75 (59.97)	44.98 (49.97)	41.14 (43.28)	40.08 (41.46)	39.22 (39.98)	35.20 (33.23)
T_4	Castor oil at 28.75 mL/2.3 kg seeds	54.76 (66.71)	50.75 (59.97)	44.98 (49.97)	43.92 (48.12)	43.06 (46.62)	39.22 (39.98)
T_5	Castor oil at 34.5 mL/2.3 kg seeds	56.77 (69.97)	54.76 (66.71)	50.75 (59.97)	49.89 (58.49)	44.98 (49.97)	41.14 (43.28)
S. Em. ±		1.13	1.13	0.79	1.10	0.79	0.79
C.D. at 5%		3.50	3.50	2.42	3.38	2.42	2.42
C.V. (%)		4.73	5.18	3.88	5.58	4.34	4.87

Note: *Figures in parenthesis are retransformed values, those outside are arc sin transformed values

Table 3: Effect of different doses of castor oil on germination per cent due to infestation by *R. dominica* in stored wheat.

Tr. No.	Treatments	Germination (%)	
		Before storage	After storage
T_1	Castor oil at 11.5 mL/2.3 kg seeds	94.00*	69.43 (87.66)
T_2	Castor oil at 17.25 mL/2.3 kg seeds	94.33	71.25 (89.67)
T_3	Castor oil at 23.00 mL/2.3 kg seeds	94.67	72.53 (91.00)
T_4	Castor oil at 28.75 mL/2.3 kg seeds	94.67	72.92 (91.37)

T_5	Castor oil at 34.5 mL/2.3 kg seeds	95.00	73.56 (92.00)
T_6	Control	94.33	55.94 (68.63)
S.Em. ±		1.01	0.79
C.D. at 5%		NS	2.42
C.V. (%)		2.39	1.97

Notes: 1. Figures in parenthesis are retransformed values, those outside are arc sin transformed values
2. * Original value
3. NS: Non-significant

Periodical Adult Mortality

The data on the effect of different doses of castor oil on adult mortality of *R. dominica* at different storage intervals are presented in Table 2. The results indicated that adult mortality increased significantly with increase in the dose of castor oil and varied across storage periods (Figure 2).

At 15 days of storage (DOS), significantly higher adult mortality was recorded in castor oil at 34.5 mL per 2.3 kg seeds, castor oil at 28.75 mL per 2.3 kg seeds and castor oil at 23.00 mL 2.3 kg seeds (99.98%) followed by castor oil 17.25 mL per 2.3 kg seeds (95.25%). The lowest mortality among treated grains was observed in castor oil at 11.5 mL per 2.3 kg seeds (89.97%). At 30 DOS, the highest adult mortality was recorded in castor oil at 34.5 mL per 2.3 kg seeds (99.98%), followed by castor oil at 28.75 mL per 2.3 kg seeds (98.63%), castor oil at 23.00 mL per 2.3 kg seeds and castor oil at 17.25 mL per 2.3 kg seeds (89.97%). Castor oil at 11.5 mL per 2.3 kg seeds recorded lowest adult mortality (79.97%). At 45 DOS, castor oil at 34.5 mL per 2.3 kg seeds recorded the highest adult mortality (89.97%), followed by castor oil at 28.75 mL per 2.3 kg seeds (86.96%) and 23.00 mL per 2.3 kg seeds (83.61%). The treatments castor oil at 17.25 mL per 2.3 kg seeds (79.97%) and 11.5 mL per 2.3 kg seeds (76.79%) recorded lower adult mortality. At 60 DOS, the highest adult mortality was observed in 34.5 mL per 2.3 kg seeds (86.34%), followed by 28.75 mL per 2.3 kg seeds (82.93%) and 23.00 mL per 2.3 kg seeds (79.23%). Lower doses continued to show reduced effectiveness. At 75 DOS, castor oil 34.5 mL per 2.3 kg seeds maintained the highest adult mortality (83.61%), followed by castor oil at 28.75 mL per 2.3 kg seeds (79.97%) and 23.00 mL per 2.3 kg seeds (69.97%), whereas castor oil at 11.5 mL per 2.3 kg seeds recorded the lowest adult mortality among treatments (59.97%).

The results are in close agreement with earlier findings of Tapondjou *et al.* (2002), who reported that plant oils act as effective grain protectants by forming a thin film or coating over grains. Similar observations were also reported by Shaaya *et al*. (1997), who emphasized the fumigant and contact toxicity of plant-derived oils against storage pests. The reduction in effectiveness over time may be due to degradation of active compounds, volatilization or reduced persistence of the oil coating on grain surfaces. Comparable trends have been reported by Rahman and Talukder (2006), who observed a decline in efficacy of botanical oils with prolonged storage duration. These results were not accordance with earlier finding of Adhikari (2023) as he reported adult mortality of *R. dominica* increase with the period of storage up to 75 days of storage. The overall order of effectiveness of different doses of castor oil as seed protectants of wheat against *R. dominica* found from current investigation more or less matches with previous works by Khaire *et al.* (1992), Abdallah *et. al.* (2001) and Ghelani *et al.* (2017).

Germination (%)

The data presented in Table 3 revealed that different doses of castor oil had significant effect on germination percentage of wheat seeds before storage. After six months of storage due to insect-pest damage there was significant reduction in germination was recorded. Before six months of storage, germination percentage ranged from 94.00 to 95.00 per cent. Highest germination was observed in castor oil at 34.5 mL per 2.3 kg seeds (95.00%) followed by castor oil at 28.75 mL per 2.3 kg seeds, castor oil at 23.00 mL per 2.3 kg seeds (94.67%) and 17.25 mL per 2.3 kg seeds (94.33%). The lowest germination percentage was observed in castor oil at 11.5 mL per 2.3 kg seeds (94.00%).

After six months of storage, germination percentage varied from 68.63 to 92.00 per cent. The maximum germination was recorded in castor oil at 34.5 mL per 2.3 kg seeds (92.00%), followed by castor oil at 28.75 mL per 2.3 kg seeds (91.37%) and 23.00 mL per 2.3 kg seeds (91.00%). The minimum germination was observed in castor oil at 11.5 mL per 2.3 kg seeds (87.66%).

These present finding supported with earlier finding as Salas (1985) reported that plant oils *viz.*, soybean, castor, coconut, groundnut, sesame and olive oils had some adverse effect on seed germination and viability at 10 mL per kg seed.

Conclusion

Overall, castor oil at 34.5 mL per 2.3 kg seeds found significantly more effective with 18.61 adult emergence followed by castor oil at 28.75 mL per 2.3 kg seeds (21.61 adults), castor oil at 23.00 mL per 2.3 kg seeds (75.63 adults). Castor oil at 17.25 mL per 2.3 kg seeds and castor oil at 11.5 mL per 2.3 kg seeds were recorded 83.05 and 102.31 number of adult emerged, respectively. Among the evaluated doses of castor oil, the highest (102.31 adults) population growth was recorded in castor oil at 11.5 mL per 2.3 kg seeds and was found less effective. Based on per cent adult mortality of *R. dominica* upto 6 months of storage, castor oil at 34.5 mL per 2.3 kg seeds found significantly superior than the rest of the treatments. castor oil at 28.75 mL per 2.3 kg seeds was found next in order followed by castor oil at 23.00 mL per 2.3 kg seeds. Castor oil at 17.25 mL per 2.3 kg seeds and castor oil at 11.5 mL per 2.3 kg seeds recorded lower adult mortality. Castor oil at 11.5 mL per 2.3 kg seeds was recorded lowest adult mortality during the storage period of wheat. Based on germination percentage after six months release of *R. dominica*, Among the treatments, castor oil at 11.5 mL per 2.3 kg seeds recorded the lowest germination percentage before storage (94.00%) as well as after six months of storage (87.66%). Castor oil at 28.75 mL per 2.3 kg seeds and castor oil at 23.00 mL per 2.3 kg seeds were the next best treatments, recorded higher germination percentages after six months of storage (91.37% and 91.00%, respectively). These treatments proved effective in maintaining seed quality over the storage period. The lower germination was observed in castor oil at 11.5 mL per 2.3 kg seeds (87.66%) and castor oil at 17.25 mL per 2.3 kg seeds (89.67%), indicating poor protection of seed viability under these conditions.

(A) Castor oil

(B) Application of castor oil to wheat seeds

(C) Experimental set up for evaluation of castor oil against *R. dominica* in stored wheat

Fig. 1 : Experimental set for efficacy of different doses of castor oil against *R. dominica* in stored wheat.

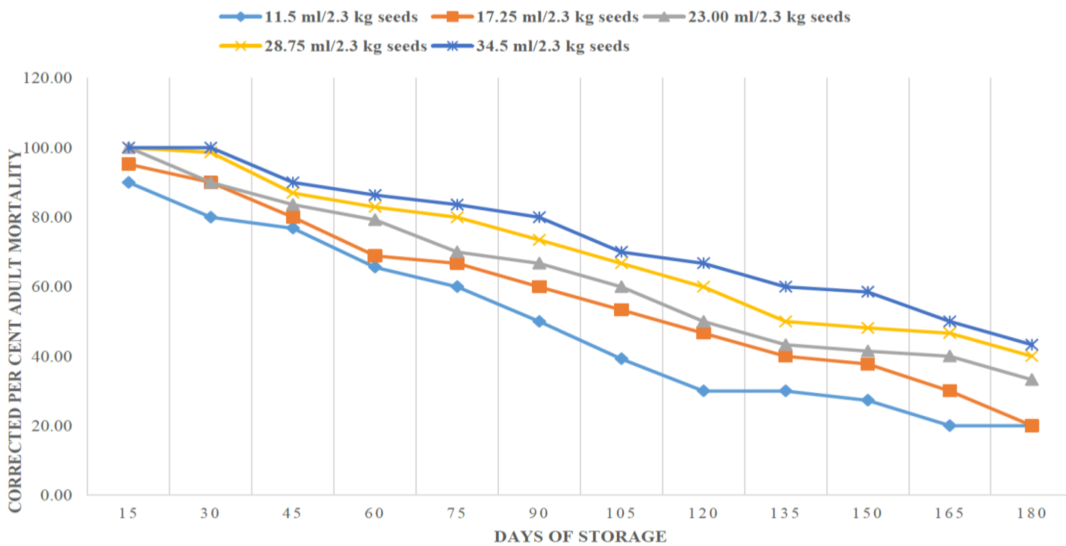

Fig. 2: Corrected per cent adult mortality of *R. dominica* upto six months of storage at different doses of castor oil

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