BIO-EFFICACY OF SOME EDIBLE OILS AND PLANT PRODUCTS FOR MANAGING PULSE BEETLE, *CALLOSOBRUCHUS CHINENSIS* (COLEOPTERA: BRUCHIDAE) IN STORED GREEN GRAM

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BY

PRIYANKA CHANDALIYA

THESIS

MASTER OF TECHNOLOGY

IN

AGRICULTURAL ENGINEERING

(**PROCESSING AND FOOD ENGINEERING**)

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Dated: / /2014

CERTIFICATE - I

This is to certify that **Miss Priyanka Chandaliya** has successfully completed the comprehensive examination held on /6/2014 as required under the regulations for Master of Technology in Processing and Food Engineering.

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Dated: / /2014

CERTIFICATE – III

This is to certify that this thesis entitled **" Bio-efficacy of some edible oils and plant products for managing pulse beetle, *Callosobruchus chinensis* (Coleoptera: Bruchidae) in stored green gram"** submitted by **Miss Priyanka Chandaliya** to Maharana Pratap University of Agriculture & Technology, Udaipur, in partial fulfillment of the requirements for the degree of **Master of Technology** in agricultural engineering in the subject of **Processing and Food Engineering**, was approved after recommendation by the external examiner and defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination on her thesis has been found satisfactory; we therefore, recommend that the thesis be approved.

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ABSTRACT

A laboratory experiment was conducted on "Bioefficacy of some edible oils and plant products for managing pulse beetle, *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) in stored green gram" at Post Harvest Biological Laboratory, Post Harvest Technology Scheme, Department of processing and Food Engineering, College of Technology and Engineering, Udaipur during 2013-14. Three edible oils viz. sesame (*Sesamum indicum* L), groundnut (*Arachis hypogaea*, L.) and mustard (*Brassica juncea* Cross) at the rates of 3,6 and 9 ml/kg seed and three plant product viz. papaya leaf (*Carica papaya,* L.), neem leaf (*Azadiracta indica*),lemon leaf (*Citrus limonium*) at the rate of 3 6 and 9 g/kg seed as grain protectants of green gram (var. Pusa Baisakhi) against pulse beetles were used (*Callosobruchus chinensis* L.). Among different edible oils evaluated for their efficacy against pulse beetle at rate of 3, 6 and 9 ml/kg grains up to 120 days of storage. The application of sesame and groundnut oils at 6 ml/kg grains were found most effective with maximum 100 per cent adult mortality, 90.31 per cent deterrence, 0.40 eggs/seed and minimum 0.10 hole/seed. While, minimum (1.33 per cent) weight loss observed in grains treated with sesame and groundnut oil at 9 ml/kg grains. Whereas, mustard oil at application of 3 g/kg grains was found least effective with maximum 0.30 hole/seed, 1.20 eggs/seed, 8.50 per cent weight loss and minimum 70.94 per cent deterrence and 92.00 per cent adult mortality.

Among different plant products evaluated for their efficacy against pulse beetle upto 120 days of storage. Significantly maximum (100%) adult mortality and 70.46 per cent deterrence, minimum (0.30 hole/seed) grain damage, minimum (10.80%) weight loss and 1.20 eggs/seed was found in grains treated with papaya leaf powder at application of 9 g/kg grains. While, minimum (58.00%) adult mortality, minimum (42.85%) deterrence, maximum 2.30 eggs/seed, 0.60 hole/seed and 22.14 percent weight loss was found in grains treated with lemon leaf powder at 3 g/kg grains

Effect on proximate content (fat, crude protein and carbohydrate) was observed after 120 days of storage. No adverse effect was found on proximate content in grains treated with edible oils and plant products. Slightly increment in fat content was found in grains treated with edible oil. Grains treated with plant products have shown up gradation in colour value after 120 days of storage. All treated grains were

found viable as well as untreated grains. Hence, no adverse effect was recorded in grains treated with both substances. It can be suggested that sesame oil, groundnut oil and papaya leaf powder have most effective for manage of pulse beetle in stored green gram upto 120 days of storage.

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CHAPTER 1

INTRODUCTION

Pulses the “wonderful gift of nature” play an important role both in Indian economy and diet. Pulses are traditionally recognized as an indispensable constituent of Indian diet. In India where the population is predominantly vegetarian, pulses are important as they are rich source of protein, amino acids, energy, minerals and certain vitamins.

1.1 Area and production

India is the largest producer of pulses in world. It has 10.84 million ha area and 19.57 million metric tone production in 2013-14(http;//www.mapsofindia.com, visited on 7/5/2013). India is the largest producer and consumer of pulses in the world accounting for 33 per cent of world’s area and 22 per cent of world’s production of pulses. India has achieved a record pulse production of 18.45 million tonnes in the year 2012-13 on 239 lakh hector area (http;//www businesstoday.today.in,visited on 2/1/2013). The total area in Rajasthan under pulses was 35 lakh hector with the annual production of 0.71 million tons in 2011. (Anonymous, 2010).

In Indian states, Maharashtra is the largest producer of green gram accounting 23.05 percent of the total production followed by Karnataka (17.46 percent). The major producing states in India are Andhra Pradesh, Orissa, Maharashtra, Madhya Pradesh and Rajasthan accounting for about 70 per cent of total production. Green gram is one of the most widely cultivated pulse crops after chickpea and pigeon pea.

1.2 Green Gram

Green gram *(Vigna radiata*) belongs to the family *leguminoseae.* It is believed that green gram is a native of India and Central Asia. The genus *Vigna* comprises about 80 species and occurs throughout the tropics. *Vigna radiata* belongs to the subgenus *Ceratotropis*, a relatively homogenous and morphologically and taxonomically distinct group, primarily of Asian distribution.

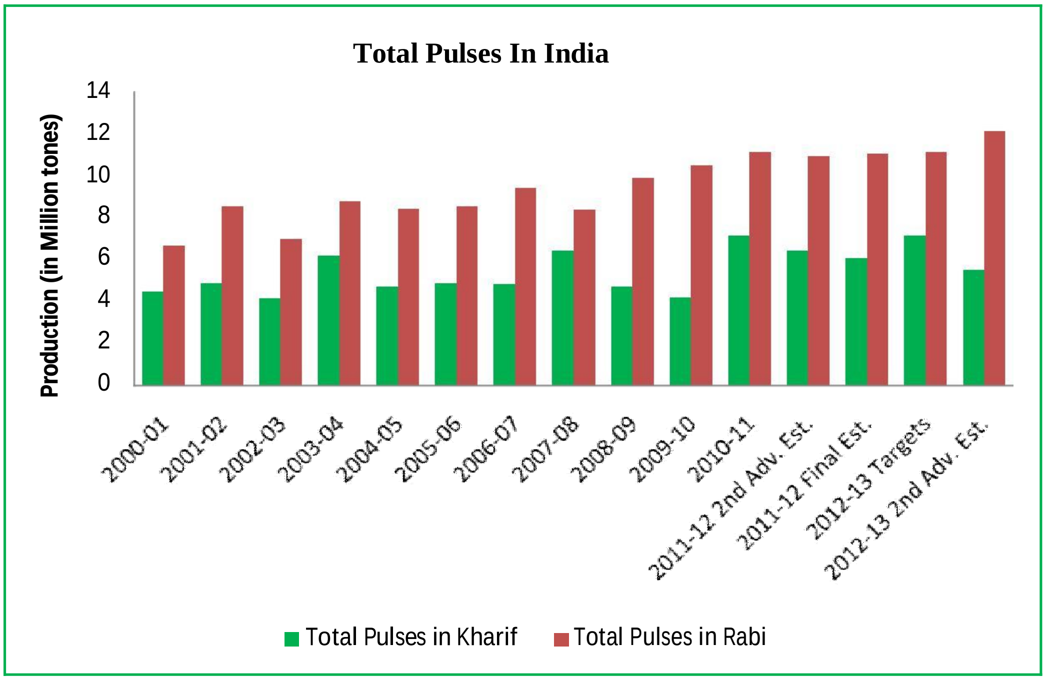

Fig.1.1 Production of total pulses in India (2001-13) (http;//www.mapsofindia.com)

i. Nutritional facts

Green gram is an important source of easily digestible high quality protein for vegetarians and sick persons. Green gram are highly nutritious containing 24.6% protein, 1.2 % fat, 56.6 % carbohydrate, ca 0.08g/ 100g, p 0.045 g/100g, fe 5.7 g/100 gm, vitamin 750 IU, thiamin 0.525 g/100 g, riboflavin 300 g, fibre 2.2 g/100 g and provides 234 Cal energy (Srivastava and Ali, 2004).

ii. Uses

Green gram is a protein rich staple food. It contains about 25 per cent protein, which is almost three times that of cereals. It supplies protein requirement of vegetarian population of the country. It is consumed in the form of split pulse as well as whole pulse, which is an essential supplement of cereal based diet. mature mung bean seeds or flour enter a variety of dishes such as soups, porridge, snacks,bread, noodles and even ice-cream. The flour may be further processed into highly valued starch noodles, bread, biscuits, vegetable cheese and extract for the soap industry.

1.3 Scope

India is world's largest producer and consumer of pulses. Still there is of 2-3 million tons between the production and consumption of pulses in the country and the gap is met through import.

Insect infestation is a major contributor to quality deterioration of durables (cereals, pulses) stored in warm and humid climates. Considerable physical and nutritional loss sustained in these countries is due to infestation of stored food products by weevils, bruchids and other insects. Apart from the detrimental economic impact, these losses pose a major threat to food security. Agrawal *et al.* (1988) reported that about 8.5 % of total annual pulse production is lost during post harvest handling and storage.

It is estimated that more than 20,000 species of field and storage pests destroy approximately one-third of the world's food production, valued annually at more than $100 billion among which the highest losses (43%) occurring in the developing world (Jacobson,1982). The quantitative and qualitative damage to stored grains and grain product from the insect pests may amount to 20–30% in the tropical zone and 5–10% in the temperate zone Food grain production in India has reached 250 million tonnes in the year 2010-2011, in which nearly 20–25% food grains are damaged by stored grain insect pests (Rajashekar *et al.* 2012).

The assessment of losses at storage has been an intricate problem since long. Though various estimates and sporadic surveys have been made by various workers from time to time, the actual losses occurring in the villages in respect of grain damage caused by various pest species still remains unanswered.

1.4 Pulse beetle

In India 17 species of bruchids belonging to 11 genera have been recorded infesting different pulses (Arora, 1977). The genus *Callosobruchus* attacks grain legumes during both pre and post harvest stages all over the world, but in India, *C. maculatus, C. analis* and *C. chinensis* are the predominant pest species of the genera (Dias, 1986). There are about 200 species of pest insects which cause damage to stored grains and grain products in storage. *Callosobruchus chinensis is a major* economically important pest of all pulses and causes 40-50% in losses of pulses storage (Gosh and Durbey,2003).

The insects spend its entire immature stage in individual legume seeds, where they cause weight loss, decrease in germination potential and diminish the market as well as nutritional value of the commodity. In India Gujar and Yadav (1978) recorded 32.2 to 55.7 per cent loss in seed weight and 17.0 to 53.5 per cent loss in protein content. In case of severe infestation cent per cent damage is caused by this pest (Pruthi and Singh, 1950).

Success achieved so far in making the stored products free from pests has been largely dependent on pesticides alone. Pesticides are the most powerful tool available for pest control. Despite these credentials, the long and indiscriminate use of pesticides has been found ecologically unsound. Insecticides were found to cause toxic effects on the produce intended for consumption, which forced a processor to look towards plants and plant products as protect ants for stored products as an alternative to the highly persistent synthetic chemicals. Global warning has cautioned us and the adverse consequences. Insecticide use are always alarming and also inducing pest out break because of pest resistance. In this condition, alternative methods of insect control utilizing botanical products are being used in many countries.

1.5 Justification

At present, pest control measures in storage rely on the use of synthetic insecticides and fumigants. Their indiscriminate in the storage, however, has led to a number of problems including insect resistance, toxic residues in food grains (Fishwick,1988), environment pollution (WMO, 1995) and increasing cost of application. Moreover, the poor storage facilities of traditional farmers in the developing countries are unsuitable for effective conventional chemical control, as most of the storage types are open to re-infestation by insect pests (Tapondjou *et al.*, 2002). In view of these problems together with the upcoming WTO regulations, there is a need to restrict their use globally and implement safe alternatives of conventional insecticides and fumigants to protect stored grains from insect infestations (Subramanyam and Hanstrum, 1995). Currently only two fumigants, Methyl bromide and Phosphine are widely used against stored product insect pests. According to the

1997 decision of the 9th Montreal Protocol, methyl bromide, which is a proven ozone depletory in the atmosphere, will be phased out by developed countries and by 2015. Furthermore, Phosphine resistance is becoming more common (Tyler *et al*, 1983) and is a matter of considerable concern. Thus there is an urgent need to develop safe alternatives of conventional insecticides and fumigants to protect stored grains from insect pest infestations.

Plant materials constitute a rich source of bio-active chemicals (Wink, 1993), hence they could lead to the development of new classes of safer insect control agents. Much effort has been focused on plant derived materials for potentially useful products as commercial insect control agents. Among the available natural resources plant material posses some desirable qualities as grain protestants which had been in practice in rural areas to protect stored grains from insect infestation.

As the botanicals are more easily available, cheaper, less persistent as compared to existing synthetic chemicals, besides, preventing quantitative and qualitative losses, they do not leave toxic residues on treated food grain. Plant-derived materials are more readily biodegradable, relatively specific in the mode of action and easy to use .They are environmentally safe, less hazardous, less expensive and readily available. Some are less toxic to mammals, may be more selective in action, and may retard the development of resistance.

Their main advantage is that they may be easily and cheaply produced by farmers and small-scale industries as crude, or partially purified extracts. In the last two decades, considerable efforts have been directed at screening plants in order to develop new botanical insecticides as alternatives to the existing insecticides. It was reported that when mixed with stored-grains, leaf, bark, seed powder, or oil extracts of plants reduce ovi-position rate and suppress adult emergence of bruchids, and also reduced seed damage rate (Talukder and Howse, 1994 and Tapondjou *et al.* 2002).

There are encouraging reports on the use of certain indigenous plant products as grain protectants (Jotwani and Sircar, 1967; Jacob and Sheila, 1990; Sharma and Singh, 1993; Sundria *et al.*, 2001 and Bhargava and Meena, 2002)

The mixing with plant oils is an ancient Indian and African method of protecting grains against insect attack (Pereira, 1983) and most of the reported studies with plant oils have involved use against stored grain insect pests. An increasing number of plant oils have been screened for preventing post-harvest losses due to insects (Golob and Webley, 1980).

Pandey (1978) showed that groundnut and other oils applied at 0.3% w/w gave complete protection of green gram Vigna aureus against C. *maculates.* Singh *et al.* (1988) applied soybean oil as seed protectant against the infestation on pigeon pea and investigate the efficiency of soybean oil as seed protectant against *C. Chinensis.* They have additional accounted that grain treated with crude and refined oil, each @ 0.5 ml/100gm grain were free from insect harm and without any noticeable loss in the seed germination and grain weight.

Mendki *et al.* (2000) tested papaya leaf powder against five commonly used pulses viz., soybean, acula gram, green gram, black gram and red gram and found that no adult of pulse beetle was found in any pulses treated with papaya leaves @1g/kg up to six months. There was no effect of papaya leaf dusting on the nutritional / Organoleptic quality and per cent germination of pulses.

Plant material based insecticides are target specific, non-toxic to human being and beneficial organisms, less prone to insect resistance and resurgence, biodegradable and less expensive and are promising grain protectants. There is a much need of knowing the insecticidal potential of indigenous plants against major stored product insect pests as those will be environmentally and socio economically feasible.

Meager information is available in literature regarding the efficacy of edible oils and plant products against pulse beetle, *C. chinensis.* Therefore, the present investigation was carried out to evaluate the bio-efficacy of edible oils and plant products against pulse beetle infesting stored green gram.

The present study was undertaken with following specific objectives.

- To evaluate the bio-efficacy of edible oils and plant products against pulse beetle.
- To determine the effect of edible oils and plant products on the proximate value of green gram.
- To observe the effect of edible oils and plant products on the color value and germination of green gram.

CHAPTER 2
REVIEW OF LITERATURE

Available literature pertaining to the present investigation was categorized and presented under different topics *viz.*, biofficacy of plant products and edible oil against *Callosobruchus chinensis* (L.) and effect of plant product and edible oil on proximate value and germination on green gram presented in this chapter:

2.1 Historical Background

Botanical insecticides such as pyrethrum, derris, nicotine, oil of citronella, and other plant extracts have been used for centuries (Singh, 1993). More than 150 species of forest and roadside trees in India produce oilseeds, which have been mainly used for lighting, medicinal purposes, and also as insecticides from ancient times to early 20th century (Mariappan,1988).

In northern Cameroon, the essential oils of plants Xylopia aethiopica, Vepris heterophylla, and Luppia rugosa are used for protection of stored grains from attack of stored grain insect pests (Ngamo *et al*. 2007). The components of citrus peels were used as grain protectant against *Callosobruchus maculatus* .Coconut oil has been found effective against *Callosobruchus chinensis*, for a storage period of six months, when applied to Vigna radiata(green gram) at 1% (Dhorey *et al*.1990).

Formulations of menthol were used as protection of pulse grain from attack of *Callosobruchus Chinensis* (Singh and Mehta, 2010). The neem oil and kernel powder gave effective grain protection against stored grain insect pests like *Sitophilus oryzae*, *Tribolium cataneum*, *Rhyzopertha dominica*, and *Callosobruchus chinensis* at the rate of 1 to 2% kernel powder or oil (Pereira.1982)The neem oil adhered to grain forms uniform coating around the grains against storage pests for a period of 180–330 days (Ahmed,1994)

Since ancient times, there have been efforts to protect harvest production against pests. The Egyptian and Indian farmers used to mix the stored with fire ashes (Abdel-Gawad, A.and Khatab, H .A,1985).The Chinese is credited with discovering the insecticidal properties of Derris species, whereas pyrethrum was used as an insecticide in Persia and China (Ahmed S. and Grainge, M., 1986).

In many parts of the world, locally available plants are currently in wide use to protect stored products against damage caused by insect infestation . Indian farmers used neem leaves and seed for the control of stored grain pests (Ahmed S. and Koppel B,1985).

In northern Cameroon, cowpeas are traditionally mixed with sieved ash after threshing and the mixture put into mud granaries or clay jars (Wolfson *et al*.,1991). In eastern Africa, leaves of the wild shrub Ocimum suave and the cloves of Eugenia aromatic are traditionally used as stored grain protectants. In Rwanda, farmers store edible beans in a traditional closed structure (imboho) and whole leaves of Ocimum canum are usually added to the stored foodstuff to prevent insect damage within these structures (Weaver *et al*, 1991).

Asian countries, food grains such as rice or wheat are traditionally stored by mixing with 2% turmeric powder.The use of oils in stored-products pest control isalsoa practice,Turmeric,garlic ancient, Vitexnegundo,gliricidia,castor, Aristolochia,ginger, Agaveamericana,custardapple, Datura, Calotropis, Ipomoea, and coriander are some of the other widely used botanicals to control and repel crop pests.

Talukder (2006) has listed 43 plant species as insect repellents, 21 plants as insect feeding deterrents, 47 plants as insect toxicants, 37 plants as grain protectants, 27 plants as insect reproduction inhibitors, and 7 plants as insect growth and development inhibitors. Eighteen species showed insecticidal potential, and antiovipositional properties against Sitophilus oryzae

2.2 Effect of Edible oil

Ahmad, *et al*.(1988) studied the effect on Seeds of six varieties of green gram (*Vigna radiata*), were treated with mustard and olive oils to certain the efficacy of these oils against attack of *callosobruchus maculatus* (F.). The impact of mustard oil on the germination of treated seed was also assessed. Varieties treated with 15 ml mustard oil/kg seed showed from complete protection to only 0.75% seed damage even after four months. However, in olive oil treatment the seed damage was from 1.69 to 5.26%. The maximum damage (5.26%) was noted in variety, 'niab mung 20-21' following the 15 ml olive oil/kg seed treatment upto four months. The seed damage in untreated controls of all the varieties was 100%. In general the mustard oil treatment was more effective than olive oil. The seed germination was not affected by seed treatment with mustard oil except for variety 'nlab mung 13-1' which showed significant reduction in germination percentage as compared to untreated control.

Khaire *et al.* (1992) studied the efficacy of ten vegetable oils *viz.* sunflower, castor,mustard, safflower, palm,groundnut, sesame, neam, karanj and maize each applied at rates of 5, 7.5 and 10 ml/kg of grain (0.5, 0.75 and 1% v/w concentration) as grain protectants of pigeon pea against *C. chinensis*. Effects on progeny emergence, loss in grain weight and germination upto 100 days after treatment were measured. Adult emergence was completely prevented by karanj oil at 0.75 and 1% and neem oil at all levels up to 100 days. No emergence of adults occurred up to 66 days with castor oil at 0.75 and 1% levels. Minimum grain loss was noted with castor, mustard and groundnut oils at the 1% level up to 100 days after treatment.

Redd**y** *et al*.(1994) observed that karanja oil, mustard oil and castor oil (10 ml/kg seed) were effective in halting the embryonic development in *C.chinensis* and protected in mung bean seed over a period of 21 months after treatment followed by neem oil which gave protection for up to 12 months. A significant reduction in germination was noticed among the treatment with neem oil and groundnut oil at 10 ml/kg where seed viability was maintained for up to 6 months, while at the lower doses (2, 5 and 6 ml/kg seed) viability was maintained up to 18-21 months respectively. Karanja oil, castor oil and mustard oil even at 10 ml/kg seed did not show only adverse effect on seed viability for up to 18 to 21 months, respectively

Ramazan (1994) evaluated effect of edible oils viz., cotton seed, sunflower, groundnut, soybean and mustard oil cowpeas and green gram against *C. maculates*. The dose of 30 ml/kg of oil tested was considerably more effective than a dose of 15 ml/kg, Indian mustard oil at 30 ml/kg completely suppressed adult emergence of the bruchid. There was no adult emergence in green gram coated with 5 and 10 ml of above oils. in green gram ;doses as low as 2, 3 and 4 ml/kg of Indian mustard, sunflower and groundnut oil suppressed adult emergence up to 5 months, wherer as, oil of neem at 2 per cent failed to control multiplication of the pest.

Singh *et al.* (1994) evaluated various oils evaluated as grain protectants at 1 and 3 ml/kg seed of gram against *C.chinensis*, the oil of taramira, coconut, sunflower sufflower and castor were found to be the most effective inhibiting oviposition. Adult emergence was lowest from the seed treated with caster, mustard, soybean, groundnut, coconut, safflower, taramira and rice bran oils at 1ml/kg seed, while at 3 ml, there was no adult emergence from the seeds treated with oils of caster, mustard, soyabean 14 day at both dosages

Khanna (1995) evaluated the black pepper (*Piper nigrum*) powder at 500 ppm used in combination with mustard oil gave significant greater protection of stored green gram(*V. Radiata*) against *C.chinensis* and *C. analis c*ompared pepper powder on its own.

Singal (1995) evaluated that coconut, grount nut and mustard oil as surface protectant proved highly effective in protecting seeds of chickpea for 8 months storage, in terms of seed damage and weight loss

Rajapakse *et al*.(1997) investigated the possible use of four vegetable oils (maize, groundnut, sunflower and sesame) in managing bruchid legume pests C *.chinensis, C. maculates* and *C. rhodesianus* was investigated. All four oils tested significantly reduced the oviposition of all 3 bruchid species at 10 ml/kg and also significantly reduced the longevity of the adult of *C. maculates* and *C. chinensis* at this dose.only maize and sunflower oil caused a significant reduction of longevity of C. *rhodidianus* at 10ml/kg.

Dhulia *et al*. (1999) reported that green gram seeds could be protected from damage by the pulse beetle ,*C. maculates* for a long period by vegetable oil treatment at 0.5%.the vegetable oils tested were mustard, groundnut,rapeseed sesame and caster at 0.5 and 1.0% (w/v). this treatment did not have any adversed effect on the cooking quality of treated seeds.

Misra, (2000) evaluated the powders *L.camara* and *T. prochumbens* at both concentrations and L.camara extract at all concentration were promising in protecting the seeds. The use of such botanical products did not affect the germ inability of the seeds.

Tripathy *et al*., *(*2001) studied the efficacy of different vegetable oils (castor, neem, pongamia, coconut, Indian mustard, sesame, soyabean and sunflower) at 2 and 4ml/k and 8 plant (*Annona Saquamosa*, *Eupatorium Glandulosum, Lantana camera, Strychnos nux-vomica, Tridax procumbens,Datura fistula, Sphoeranthus indica Sphaeranthus indicus*) and neem powder at 20 and 40ml/kg and 3 plant (L.camara, Ageratum conyzoides and vitex negunda) extracts at 2.5,5.0,7.5 and 10.0 ml/kg against pulse beetle, *C.chinensis*, infesting blackgram (cv. T9) was studied. All the oil treatment was superior in protecting the seeds from pulse beetle attack. The oil of neem,caster and coconut at both the doses proved most effective in protecting the seed for about 9 months after treatment.

Ahmed *et al.* (2003) evaluated neem and sesame oil and found both oils can control the larvae of *C. chinensis* inside the cotyledons of adzuki beans.

Raghvi and Kapadia (2003) studied the efficacy of different vegetable oils on seed protectants of pigonpea against *C. maculatus* and results indicated that neem and coconut oils @10ml/kg seed provided the complete control of grains against this bruchid for 6 month, followed by kanaraj, mustard and castor oil @10 ml/kg seed. Sesame and groundnut oils @10 ml/kg seed gave more than 94% protection upto 4 months of storage. The germination of pigonpea seed not impaired due to different oil treatments.

Singh,(2003) studied the effect of edible oils (coconut, mustard, sunflower, sesame and mahua), non edible oils (neem ,castor,tarpin and noorani)as well as a hair oil of arnica, himtaj,amla,banphool and navratan as a surface protectants for pigen pea against *C.chinensis* at 8 ml/kg seed. All oils proved highly effective in protecting the seed up to 9 month storage in terms of seed damage and weight loss. These oils prevented egg laying and controlled the population build up of beetle.

Singh and Sharma (2003) tested 9 plant oils against C. *chinensis* and found significant protection against this pest. The oils were used @ of 2.5, 5.0and 10 ml/kg seeds coating 4 to 6 hours after treatments gave complete protection while 3,6, and 9 month after treatment gave partial to complete protection of seed of green gram against pulse beetle.

Yadav *et al.(*2004) investigated the effect of vegetable oils on the orientation and oviposition of pulse beetle on green gram during storage .sesame ,coconut ,mustard ,groundnut, soybean and groundnut and non edible oils(mahua, caster, karanj and neem) were mixed with seed at 10 ml/kg seed. Seeds were exposed to insect at 1.10,30 and 75 days after seed treatment .vegetable oils reduced beetle incidence on seed to 5.91-7.50 beetle, compared to the control (16 beetle).Among vegetable oils, mahua oils was the most effect .Oviposition was reduced by vegetable oil treatment. Neem oil reduced the number of oviposited eggs to 3.58 eggs, compared to untreated control (91.25)

Satyavir. (2005) due investigated the multiplication of the pulse beetle, *C. maculatus*, was studied at 4 levels of initial infestation, i.e. 1, 2, 3 and 5 pairs of newly emerged adults, on moth bean (*Vigna aconitifolia* cv. Jadia) and cowpea (*V. unguiculata* cv. FS 68) seeds for a period of 6 months. The population of the pulse beetle on both seed materials increased with the period of storage in bags kept in an incubator at 28±2°C and 50-60% relative humidity. Pulse beetle populations increased from the initial infestation levels to 510-1258 on moth bean and 417-1027 on cowpea after 6 months of storage. These infestation levels resulted in 35-69% weight loss in moth bean and 18-38% weight loss in cowpea after 6 months of storage. Insect oviposition was affected by the colour, texture and volume of seed. Bright-coloured and smooth-surfaced seeds with greater volume were much preferred for oviposition and egg laying. In the bioassay of the efficacy of plant oils (karanj), neem, coconut, mustard, safflower and groundnut oil) as seed protectants against the pulse beetle, both karanj and neem oil gave equal protection of seeds, which was comparable to that obtained with the standard malathion, after 6 months of storage.

Rahman and Talukder (2006*)* conducted study on the bioefficacies of different plant/weed derivatives that affect the development of the pulse beetle,*Callosobruchus maculates* F. (Coleoptera: Bruchidae) fed on black gram, *Vigna mungo, seeds*. Plant extracts, powder, ash and oil from nishinda (*Vitex negundo* L.), eucalyptus (*Eucalyptus globules* Labill.), bankalmi (*Ipomoeasepiaria* K.), neem (*Azadirachta indica* L.)safflower (*Carthamustinctorius* L.), sesame (*Sesamum indicum* L.) and bablah (*Acacia arabica* L.) were evaluated for their oviposition inhibition, surface protectant, residual toxicity and direct toxicity effects on *C. maculates*. The results showed that plant oils were effective in checking insect infestation. The least number of F_1 adults emerged from black gram seeds treated with neem oil. The nishinda oil extract was the most toxic of three extracts tested (nishinda, eucalyptus and bankalmi). Bablah ash was the most effective compared to the powdered leaves of nishinda, eucalyptus and bankalmi. The powdered leaves and extracts of nishinda, eucalyptus and bankalmi, at a 3% mixture, provided good protection for black gram seeds by reducing insect oviposition, F_1 adult emergence, and grain infestation rates.

The oil treatment did not show adverse effects on germination capability of seeds, even after three months of treatment.

Bajya *et.al* (2007) evaluated 3 vegetable oils, i.e. neem (*Azadirachta indica*), castor (*Ricinus communis*) and mustard (*Brassica juncea*) at 0.4, 0.8 and 1.2 ml/100 g seeds, and leaf and kernel powder of neem, karanj (*Pongamia glabra* [*P. pinnata*]) and tulsi leaf powder (*Ocimum sanctum* [*O. tenuiflorum*]) at 4.0, 8.0 and 12.0 g/100 g seeds against pulse beetle. Suitable controls were used in all the experiments. The 3 vegetable oils at 0.4, 0.8 and 1.2 ml/100 g seeds caused adult mortality of pulse beetle significantly up to 3 days of treatment in comparison to the control. The adult mortality also increased with the increase in dose of each treatment. Neem oil was the most effective in giving the maximum adult mortality (96.0%) after 3 days of treatment at 1.2 ml/100 g seeds, whereas, in the control no mortality was observed. The next best treatment was the castol oil at 1.2 ml/100 g seeds, causing 84.0% mortality of the pest. The 5 plant products at 4.0, 8.0 and 12.0 g/100 g seeds gave significant adult mortality of pulse beetle up to 3 days of treatment compared to the control. The adult mortality increased subsequently with the increase in doses at increasing intervals. The maximum percentage mortality was recorded with neem kernel powder (65.0), followed by karanj kernel powder (59.0), neem leaf powder (51.0), karanj leaf powder (45.9%) and tulsi leaf powder (30.6) at 12.0 g/100 g seeds after 3 days of treatment, whereas, in the control no mortality was observed.

Khalequzzaman *et al.* (2007) evaluated seven vegetable oils viz., sunflower *(Heliunthus annus,* L.), mustard (*Brassica juncea* Cross), groundnut (*Arachis hypogaea*, L.), sesame (*Sesamum indicum* L.), soybean [*Glycine max* L. (Merril)], olive (*Olea europea*) and oil palm (*Elaeis guineensis* W. J. Jacquin), each were applied at the rates of 5, 7.5, and 10 ml/kg of grain (0.5, 0.75 and 1% v/w concentrations) as grain protectants of pigeonpea against the pulse beetles (*Callosobruchus chinensis* L.). Effects on progeny emergence, loss in grain weight, and germination up to 66 days after treatment were measured. Adult emergence was completely prevented and the minimum grain loss was achieved by groundnut oil at 1% up to 66 days after treatment. Since treatments with groundnut and palm oils at 5 ml/kg showed high acceptability by consumers, it can be recommended for *C. chinensis* control in stored pigeonpea for approximately two months.

Swella, (2007) evaluated the effectiveness to control the bruchid, *Callosobruchus maculatus* in cowpea by the synthetic insecticide Actellic dust, and by the natural protectants ash, coconut oil, powdered cloves and black pepper. The data collected included the number of damaged and undamaged seeds, weight of damaged and undamaged seeds and the number of live and dead bruchids. Seeds treated with actellic dust and black pepper powder had significantly low percentages of damaged seeds. Black pepper powder and coconut oil showed good potential in protecting cowpea against bruchid damage

Saxena and Saxena (2010) studied the efficacy of edible oils against 3 days old. C. Maculates on chick pea seed and found that significant mortality of test insect together with reduction in oviposition rate, % adult emergence and % weight loss of chick pea seed was observed. However, oil treatment did not significantly affected chickpea germination when compared to control.

Bhardwaj *et al*. (2012) evaluated six vegetable oils viz., mustard, neem, karanj, cedar, apricot and olive were evaluated for rotection of pea seed from pulse beetle, *Callosobruchus chinensis* L. One day after treatment, maximum mortality (22.22%) was observed in neem oil coated seeds which was statistically at par with karanj oil (16.67%). On day-3, neem coated seeds resulted 55.56% mortality and its 3 and 1 per cent concentrations were equally effective (50.00 and 43.33% mortality). On day-7, highest mortality (90.00%) was observed in neem coated seeds followed by karanj (77.78%), cedar (66.67%) and mustard (36.67%). Complete mortality was recorded in neem oil coated seeds at 5 per cent concentration and was significantly higher than 3 per cent (90.00%) and 1 per cent (80.00%) concentration. After 15-day observation, neem and karanj resulted 100.00 and 95.56 per cent kill, respectively. Maximum mortality was observed in seeds coated with neem oil (72.22%), followed by karanj (65.56%), cedar (53.33%), mustard (38.44%), olive (32.89%) and apricot (29.56%). The minimum number of eggs (4.78 eggs/5 females) recorded in neem oil coated seeds was statistically at par with karanj (6.67eggs/5 females). Minimum adult emergence (0.56 beetles) was recorded in neem oil coated seeds was statistically at par with karanj (0.89 beetles) after sixty days of treatment.

Ibrahim,(2012). Conducted the study on the efficacies of different plant oils on development of the cowpea weevil, *C. maculates* F. (*Coleoptera: Bruchidae*) fed on chickpea seeds. Plant oils from sunflower (*Helianthus annuus* L.), cotton seed (*Gossypium* spp.), olive (*Oleaeuropaea L*.), Sesame seed (*Sesamum orientale* L.), soybean, (*Glycine max L.)* and Kolza, (*Brassica napus L.*) were assessed as protections of cowpea weevil. The results showed that plant oils were effective in decreasing insect infestation. Plant oils tested, Sesame and Sunflower seeds were found to be the most effect in ovipositor deterrence percent of bruchids at dose of 7.5 ml/ kg seeds (v/w). The percentage of oviposition deterrence from the infested chickpea was significantly reduced in treatments to which oils of sesame (98.49%), olive (96.54%) and sunflower (95.37%) had been added. Looking into the adverse effects of synthetic pesticides the study demonstrates that these plant oils can play an important role in protection of chickpea from insect invasion during storage. The least number of F1 adults emerged from chickpea seeds treated with cotton seed oil. The sesame seed oil at 5 and 7.5 ml/ kg seeds was the most effective in reduces adult emergence with 96.03 and 96.22%, respectively. The oil treatment did not show adverse effects on germination capability of seeds, even after three months of treatment.

Lal and Viola (2012) studied four vegetable oils viz, neem oil (*Azadirachta indica*), eucalyptus (*Eucalyptus globulus*) , sunflower oil (*Helianthus annus*) and castor oil (*Ricinus communis*) each were applied @ 1 ml and 3 ml/ kg seeds of pigeon pea against the pulse beetles (*Callosobruchus maculatus* fab.).their effectiveness with both the dosages i.e. 1 ml and 3 ml/ kg seeds in reducing the egg laying and adult emergence and normally delayed the developmental period .the infestation of beetle after 120 days of treatment with higher of eucalyptus oil, castor oil and neem oil dose i.e. 3ml/kg seed was recorded in terms of reduction in weight loss of the grain , which gave 100% control while 1ml/kg seed dose of these oils was also found effective (0.33, 0.46and 0.55%).results showed that the oils do effect the protoplasm of the egg and larval feeding , hence oils proved to be most effective and safest method to control the pulse beetle for stored pulses. out of two dosages applied, 3ml/kg seed was found most effective in minimizing the pest incidence. seed treatment with different oils @ 1ml and 3ml/kg seed has no significant adverse effect on seed germination after 120 days of treatment.

Chatteji and Pal (2014) investigated six ethanol extracts viz. Neem leaf, rhizome of ginger, garlic and turmeric, eucalyptus leaf and leaf of Lantana camera were evaluated to find out their effect on biological parameters of pulse beetle (*Callosobruchus chinensis)* on pea during 2009-2010. It was observed that all the botanicals were superior over control to suppress some biological parameters such as egg laid/seed, egg laid/day, oviposition period, hatchability per cent, adult formation and adult survivorship while prolonged some developmental stage such as incubation period and larval-pupal period. Among the botanicals, garlic was found to be very effective against larval development of pulse beetle there by no adult emergence followed by neem and turmeric with 4.76 and 6.67% adult emergence, respectively

2.3 Effect of Plant Products

Valsamma and Patel (1992) evaluated the neem leaf powder (10%) against pulse beetle, *C. analis* on greengram and reported that at 30 and 60 days after treatment, the grain damage was 4.3 and 4.8 per cent as against 8.7 and 92.8 in the untreated control, respectively.

Kahare *et al*. (1993) made an attempt to explore herbal product as protectants against *C. chinensis in grains of Bengal gram. The lowest number of eggs of the bruchid was laid on* chickpea treated with a 1 percent extract of *Azadirachta indica* A Juss and 2 percent extract of *p.glabra*.

Juneja and Patel (1994) used neem leaf powder used at 5 per cent (W/W) to protect green gram against pulse beetle, *C. analis* revealed 7.5 per cent adult mortality at three days after release when compared to 0.00 mortality in the untreated control .

Kumari and Singh (1998) tested the efficacy of some botanicals against pulse beetle. Five types of botanical dust viz., black paper powder, neem leaf dust and mangraila powder were proved to be equally effective in respect of numbers of eggs laid, number of adults emerged and reduction in damage to grains by the pest.

Rajapakse *et al*. (1998) evaluated the effect of dried leaf powders of *Piper nigrum*, *Annona reticulata*, *Azadirachta indica*and *Capsicum annuum* and dried peel of lemon (*Citrus limon*) on oviposition, adult emergence and adult mortality of *Callosobruchus maculatus* was studied on cowpea (*Vigna unguiculata*) seeds, in the laboratory at 27-30°C and 60-80% rh. *Azadirachta indica* gave the highest reduction in oviposition of *C.maculatus* (37.5%), followed by *Annona reticulata* (39%). *Azadirachta indica* caused a significant reduction in adult emergence (20.3%). Lemon peel gave the greatest mortality (8.3%), while *P. nigrum*powder gave 8.25% mortality. .

Shrvale *et al.* (1998) evaluated the neem leaf powder (1%) against *C. chinensis* in chickpea and observed that the adult mortality at 48 hours after release was 1.25 per cent with a weight loss of 10.78 per cent after 20 days.

Mendki *et al.* (2000) tested papaya leaf powder against five commonly used pulses viz., soybean, bengal gram, green gram,, black gram and red gram and found that no adult of pulse beetle was found in any pulses treated with papaya leaves @ 1g/kg up to six months. There was no effect of papaya leaf dusting on the nutritional/Organoleptic quality and per cent germination of pulses.

Misra, (2000) evaluated black gram seeds with 3% dried leaf powders of *Vitex negundo, Aegele marmesl, Azadirachta indica,Datura stramonium,Ocimum sanctum, Ocimum tenuiflorum,lantana camara, annona squamosa, citrus limon,* and fruit powder of *Capsicum annum,* and rhizome powder *of accorus calamus* for control of *callosobruchus chinensis* during storage in jars. These treatment were compared over five months with the local treatment of red soil powder,cow dung ash powder(both at 3%) and mustard oil coating.tabulated data on the effect of the treatment on the fecundity of *C. Chinensis* . on stored black gram,seed weight loss and seed quality are presented. All treatment resulted in lower *C. Chinensis* fecundity and seed weight losses that the untreated control. However, only the cow dung ash and mustard oil treatment completely inhibited oviposition. However, the *Vitex negundo, Aegele marmelos,Azadirachta indica* and *Datura stramonium* treatments reduced fecundity more than the other powder treatment and , as with the cowdung ash,mustard oil and L. camera treatments completely prevented losses in seed weight and seed quality.

Yogita *et al.* (2001) evaluated the leaf extracts of plants i.e. neem, *A. indica;* arandi, *Ricinus communis* L; karanj, *Derris indica* (Lam.) Bennet [*Pongamia pinnata* (L.) Pierre]; pilu, *Salvadora oleoides* Decne; marva, *Ocimum basilicum* L.; amaltas, *Cassia fistula* L.; blue gum, *Eucalyptus globules* Labil, guava, *Psidium pyriferum* L.; datura, *Datura metel* L. and Bougainvillea as grain protectants of sorghum seeds at 1.0, 2.5, and 5.0 ml per 100 g against *T. castaneum.* Insect survival percentage was minimum (16.66%) with treatment of neem extract at 1.0 ml per 100 g seeds. In all other extracts, survival rate ranged from 23.33 to 48.33 per cent. All the plant extracts at 1.0, 2.5, and 5.0 ml per 100 g seed treatment prolonged the developmental period of *T. castaneum* from 5 to 15 days. The weight loss in the seed treatment with the extracts at 1.0 ml per 100 g seed ranged from 4.67 to 12.79 per cent at 2.5 ml per 100 g seed it ranged from 2.65 to 8.25.0 per cent; and at 5.0 ml per 100 g seed it ranged from 2.67 to 4.13 per cent.

Awati *et al.* (2002) tested extracts of eight plants namely Qarat (*Acacia nilotica*), Mustafal (*Annona squamosa*), Shereesh (*Azadirachta indica*), Luban (*Boswellia sacra*), Kheshkhash (*Crotolaria juncea* [*Crotalaria juncea*]), Zebrot (*Jatropha dhofarica*), Yas (*Myrtus communis*) and Suwwad (*Suaeda aegyptiaca*) were prepared by steeping shaded dried leaf or seed powder of each plant in water and solvent (methanol or ethanol). The extracts were tested for their insecticidal and repellent properties against the pulse beetle, *Callosobruchus chinensis*. The extracts from the seeds of *Annona squamosa* recorded 100% mortality of beetles within twenty and four hours of their exposure to methanol and ethanol extracts, respectively. The other extracts that caused high mortality were from *Acacia nilotica*, *Crotalaria juncea*, *Myrtus communis* and *Suaeda aegyptiaca* in methanol and *Boswellia sacra*, *Jatropha dhofarica*, *Suaeda aegyptiaca* and commercial neem in ethanol. The extracts of *Myrtus communis* in methanol were highly repellent to the beetles compared to other extracts. Legume seeds treated with extracts of *Annona squamosa* were not repellent, rather the beetles were attracted to them.

Juneja and Patel (2002) examined green gram seeds treated with 1, 2, 3, 4 or 5% (w/w) powdered custard apple (*Annona squamosa*) or black pepper (*Piper nigrum*) seeds, mint (*Mentha piperita*) leaves, orange (*Citrus reticulata*) peels or neem (*Azadirachta indica*) seed kernels to determine the persistence of the botanicals as protectants of green gram against the pulse beetle (*C. analis*). The number of eggs per 100 grains decreased with increasing concentrations of the botanicals used, although grain damage increased with the duration of the treatment. Seeds of green gram treated with 1% of either powdered custard apple or black pepper seeds were totally protected from the pulse beetle for up to 5 and 4 months, respectively

Kotkar *et al.* (2002) evaluated foliar extracts of *A. squamosa* against pulse beetle, *Callosobruchus chinensi* and found that the flavonoids isolated from aqueous extracts of *A. squamosa* showed 80 per cent insecticidal activity against *C. chinensis* at a concentration of 0.07 mg/ml. Various physico-chemical tests, chromatographic and spectroscopic studies with partially purified aqueous extract indicated the presence of flavonol-type flavonoids. This may provide a useful beginning for the development of botanical pesticides for post harvest safeguard of pulses.

Yadav *et al.* (2002) studies to determine the effect of botanical insecticides, namely neem (*A. indica*) extract, undi (*Calophyllum inophyllum* L.) extract karanj (*Pongamia glabra* Vent. [*P. pinnata*]) extract, eucalyptus (*Eucalyptus spp*.) oil and lemon grass [*Cymbopogon flexuosus*) Watson] oil at 0.1, 0.5, and 1.0 ml per 100 g sorghum seeds, on the stored product pest *C. cephalonica*. Neem extract at 1.0 ml per 100 g seeds resulted in the longest total life cycle (57.8 days), highest reduction in adult emergence (85.7%), lowest number of eggs laid per female, highest reduction in egg viability (65.3%) and shortest longevity for males (3.3 days) and females (4.8 days). There was no observed adverse effect on the germination of sorghum seeds at any interval.

Singh (2003) studied and found that the seeds of khesari (*Lathyrus sativus*) can be effectively protected from the pulse beetle *C. chinensis* by treatment with the dried leaf powder of neem [*Azadirachta indica*] at the rate of 0.5-2.0 mg/100 g seed. It provided good results in respect of toxic effect, safety and economy.

Dwivedi and Venugopalan (2004) evaluated leaf extract of *Tabernaemontana divaricata* was blended with that of *Quisqualis indica*, *Chenopodium album*, *Annona squamosa, Anethum sowa* and *Tamarindus indica* at 1:1 ratio (v/v) and assessed for their oviposition deterrent action against the pulse beetle, *Callosobruchus chinensis*, on cowpea seeds. When mixed with *A. squamosa* and *C. album*, the mixture resulted in 97.15 and 94.70% deterrence, respectively, while with *Q. indica* it gave 75.15% reduction in oviposition over the control. The other two combinations resulted in moderate reduction in oviposition, varying from 51.83 to 57.74%.

Singh *et al.* (2004) tested the dried powders of 8 plant material ,i.e. kapoor tulsi leaf (*Ocimum kilimandscharicum),*tulsi leaf (*O.sanctum*),neem leaf (*Azardirachta indica*), bidibg seed(*Embelia ribes*),thuja leaf (*Platycladus orientalis*),doanaa leaf (*Artemisia sieversiana*), amngo ginger rhizome (*curcuma amada*) and ginger rhizome (Zingiber officinale), for theireffects on pulse beetle (*callosobruchus maculates*) in green gram.Ten gram of seeds treated with dried powder (5g powder/kg seed) wee kept in specien tubes. The number of adult that emerged was recorded at 15 days onwards. survival percentage was also calculated. Bidang seed powder recorded the lowest values for number of laid eggs (32.0) and number of emerged adult (4.7). Kapoor tulsi,bidang seed and doanaa leaf powder recorded the lowest per cent adult emergence(10.4,15.2 and 18.0 %).

Swain and Baral (2004) conducted the laboratory experiments during 2000-01 to determine the effect of different plant material on rice weevil (*Sitophilus oryzae)* and pulse beetle (C.*chinensis*). the plant used were akanda (*Calotropis procera*), acacia (*Acacia sp*.),begonia (*Vitex negundo*), eucalyptus (*Eucalyptus globules*), karanja (P.glabra) and neem (A. *indica*). Leaves of all the plants were used in the forum of dusts. One gram of grounded plant dusts were mixed with one hundreds gram of wheat and black gram seeds. With both the insects,the plants dusts showed significant difference between different treatments. In S. oryzae, the powdered neem dusts while in C.*chinensis* the begonia dusts showed good efficacy in controlling the insect than the other treatment.

Biswas and Biswas,(2005) evaluated plant leaf dusts *i.e* eucalyptus (*Eucalyptus citriodora*), tulsi (*Ocimumsactum[Ocimum tenuiflorum]),* neem(*A. indica*),airpple (*Lantana camara*),nishinda (*Vitex negunda*) and vasak (Adhatoda vasica [*Justicia adhotoda*]) for their effectiveness as grain protectants against the pulse beetle (*Callosobruchu*s *chinensis*). Seed of pulse cv. Mahamaya-1 were treated with the different plant leaf dusts at 2.5 and 5.0 g/kg of seed grain. The lowest fecundity (24.3 eggs), lowest Bengal gram seed damage (9.3 %) and lowest weight loss (3.1 %), were observed in Nishinda leaf dust, which was found most effective.

Chander *et al*. (2007) studied the effects of 11 grain protectants, namely neem (*Azadirachta indica*) seed kernel powder at 20 g (T_1), neem oil at 10 ml (T_2), mustard oil (T_3) and groundnut oil (T_4) at 7.5 ml each; turmeric powder at 3.5 g (T_5), mustard oil + turmeric powder at 3.75 ml+1.75 g/kg seed (T_6), groundnut oil + turmeric powder at 3.75 ml+1.75 g/kg seed (T_7); and 7 cm covering with each of saw dust (T_8), sandy soil (T_9), dung cake ash (T_{10}) and wheat husk covering (T_{11}) on egg lying, adult emergence and seed damage by *C. chinensis* on treated and untreated (control) green gram seeds at 1, 35, 70 and 105 days after storage. Green gram seeds treated with all the grain protectants resulted in significantly lesser number of eggs laid by *C.*

chinensis compared to the control after 1, 35, 70 and 105 days of storage. The minimum number of eggs (0 egg/500 seeds) was observed in T_2, however, it was at par with T_8, T_9, and T_{10}. T_5 (67 eggs/500 seeds) was the least effective, followed by T_{11} (35 eggs), after 105 days of storage. All the grain protectants were significantly effective based on adult emergence and seed damage compared to the untreated control after 35, 70 and 105 days of storage. There were no adult emergence and seed damage after 105 days of storage with T_2, T_9 and T_{10}. The maximum (77.33) number of emerged adults and seed damage (7.20%) were recorded with T_{11}.

Laxmi and Venugopal (2007) tested seed powders of *Vitex negundo*, *Acorus calamus* and *Curcuma longa* at 3 per cent; palmarosa [*Cymbopogon martinii*] spike powder at 3 per cent; neem kernel dust at 3 per cent; activated clay at 1 per cent; Teepol at 0.1 per cent; and seed and leaf powders of *Annona squamosa* at 3% against *Callosobruchus maculatus*. The seed powders of *Annona squamosa* and rhizome powder of *Acorus calamus* resulted in minimum egg-hatching of *Callosobruchus maculatus* and larvae did not complete the development. The weight loss was also minimum in this treatments. However, seed treatment did not affect the germination of green gram seeds.

Akhter and Rahaman (2008) evaluated three indigenous plant materials namely neem (*Azadirachta indica*), nishinda (*Vitex negundo*) and dholkolmi (*Ipomoea crassicaulis*) against the pulse beetle, *C. chinensis* on chickpea and found that all the plant materials had grain protection effects against pulse beetle. Leaf dust of dholkolmi was found more effective than neem and nishinda regarding grain protection and increased seed germination of chickpea. Per cent egg bearing seeds, number of eggs per 15 seeds and adult emergence were significantly higher in untreated seeds whereas the lowest oviposition rate was recorded in seed treated with dholkolmi. Adult emergence per 50 g seeds was found to be significantly the lowest in dholkolmi treated seeds. Comparatively lower number of damaged seeds (6.33%), seed weight loss (10.83 g) and higher seed germination (60.33%) were obtained in seeds treated with dholkolmi leaf dust, over control treatment.

Govindan and Nelson (2008) conducted studies to examine the effect of mixtures of plant powders on *C. maculatus*. To test the synergistic effect of botanicals, ten mixtures of plant powder were made and tested. Highest mortality

(94.44%) was observed in *Annona squamosa* leaf powder 0.5 per cent + *Anamirta cocculus* seed powder 0.5 per cent at 168 hr after the treatment Minimum number of eggs (70.00) were laid in *Helicteres isora* 0.5 per cent + *Nicotiana tabacum* 0.5 per cent when compared to 220.00 eggs in untreated control.

Moyin *et al.* (2010) evaluated the effectiveness of neem leaf, wood ash extracts, modified neem leaf extract, Apron star 42WS and Karate 720EC as seed treatment and pest control in maize. The modified neem leaf extract performed better in germination counts, reduction of damaged leaves, insect population and yield of maize than the sole application of neem leaf and wood ash

Akunne, *et al.* (2013) studied the plant leaf powders prepared from two plant species, *Vernonia amygdalina* (bitter leaf) and *Azadirachta indica* (neem) were used against adult cowpea weevil, *Callosobruchus maculatus* (fab.) on cowpea grains. the leaf powders of *Vernonia amygdalina* and *Azadirachta indica* were applied separately and in mixtures in the ratios of va100%, az100%, va50%:az50%, va20%:az80% and va80%:az20% respectively. They were evaluated under ambient laboratory conditions (30±3◦c and 75±3%). Mortality of adult *c. maculatus* at 24, 48 and 72hrs after treatment were recorded and compared with the control. All concentrations recorded higher mortality than the control except the mixture with the ratio va 20% : az 80%. The powder application at az100% proportion caused the highest mortality, during the exposure period. It was also significantly ($p<0.05$) different from the control in adult mortality.

2.4 Effect on Germination

Braich and Simwat (1984) studied the effect of three level of infestation i.e 1,2,3 pairs per 500g moong of intial infestation of *C.chinensis* and *C. maculates* on the population build up and resultant loss to moong. They further reported that weight loss,grain damage and germination,accordingly varied from 1.7 to 21.5,1.6 to 53.3 and 96.3 to 59.7 percent,respectively. The loss of moong wass significantly higher at higher (3 pairs) level of infestations of insect species than 2 pair and one pair.

George (1990) evaluated some plant product 10 per cent and malathion and fenvalerate @0.5 and 0.02 percent, respectively, against *C. analis*. He reported that neem kernel paste suspension and neem seed kernel powder proved to be more effective as compared to neem leaf powder in reducing the pulse beetle (c *.analis*) damage. None of plant products and insecticides had shown adverse effect on germination

Gupta et al (1991) studied the efficacy of seed treatment of groundnut, neem mustard,castor and karanj oils in green gram and chickpea against pulse beetle, *C.chinenesis*, and their effect on seed germination. Oil treatment with 10 ml/kg gave complete protection from bruchid damage,at least up to one year of storage in both pulse. There was no adverse effect on germination in chick pea, while in green gram germination was adversely affected.

Tripathy *et al.* (2001) studied the efficacy of 9 different vegetable oils (castor, neem (*Azadiracgata indica*) at 2 and 4 ml/kg, 8 plant(*Annona squamosa, Eupatorium glandulosum, Lantana camara, Strychnos nux-vomica, Tridax procumbens, Datura fistula,Sphoeranthus indica (spheranthus indica and neem)* powder at 20 and 40 gm/kg, and 3 plant (*L.camara,Ageratum conyzoides and Vitex negunda*) extracts at 2.5, 5.0,7.5 and 10.0 ml/kg against pulse beetle, C.chinensis,infesting black gram(cv. T_9). All the oil treatment were superior in protecting the seeds from pulse beetle attack than malathion treatment (60 ppm) and control. The oils of neem, castor and coconutat both the doses proved most effective in protecting the seed for about 9 months after treatment. Among the plant powder *L. camara* and *T. procumbens* at both concentrations and L. camara extracts at all concentrations were promising in protecting the seeds. The use of such botanical powder did no affect the germination ability of the seeds.

Bhargava and Meena,(2003) tested six vegetable oils,i.e. castor (R.*communis),* mustard (B. juncea), groundnut (A. hypogaea),sesame(*Sesamum indicum*),coconut (*cocos nucifera*) and sunflower (H. *annuus*), against C.*chinens*is in cowpea. All the oils caused significant mortality in adult after three days of treatment. The castor oil at 1.0 ml/100 g seeds was found to be the most effective causing 80.7 percent in inhibiting the oviposition (26.6 eggs per female) compared to 79.4 eggs per female in untreated seeds. At 1.0 ml/ 100 g seed , castor caused maximum reduction in egg viability (61.7%), followed by mustard oil (56.7%). The treatment with castor oil at 1.0 ml/100g seeds causd the maximum reduction in adult emergence in F_1 generation (85.0 %), followed by mustard oil (83.7%),groundnut oil (73.3%). No advice effect of tested oils was observed on the gernmination of cow pea seeds up to 150 days of treatment.

Raghvani and Kapadia,(2003) studied the efficacy of different vegetable oils on seed protectants of pigon pea against *C.maculatus* and result indicated that neem and cococnut oils @ 10 ml/kg seed provided the complete control of grain against this bruchid for six months, followed by karanj, mustard and castor oils @10ml/kg seed. Sesame and groundnut oils at 10 ml/kg seed and karanj oil @ 5 ml/kg seed gave more than 94 percent protection upto 4 months of storage. The germination of pigeonapea seed not impaired due to different oil treatement.

Bhadauria and Jakhmola, (2005) studied the oviposition preference, survival of the pulse beetle (C. maculates) and the effect of infestation intensity on the extend of losses and seed germination in different pulses viz. French bean,pigeonpa ,chickpea,green gram, pea, black gram and cowpea in the laboratory. Black gram, French bean and pigeonpea were found less preferred for oviposition by the beetle as only 50.6 to 52.6 eggs were laid. Cowpea was preferred for oviposition (171.6 eggs) and survival (78.4 %),followed by green gram. Neonate larvae of the pulse beetle were not able to penetrate the seed coat of Frechbean; hence no losses in seed weight occurred. In other pulses with intensity of one hole per seed,the loss within the damage seed was minmum in pea (8.8%) and chipea (11.1%) and maximum in green gram (55.4%). These losses were inversely proportional to seed size,although such correlation was not significant. Infested seeds of green gram, black gram and pigeonpea having only a single hole per seed failed to germinate, while only 20,40 and 52% of the infected seeds of pea,chickpea and cowpea were able to germinate. Pulse beetle infestation generally reduced seed germination by 30 % in cowpea to 72
% in black gram. Germination of seeds having two holes was very much lower than those with only one hole.

Yadav and Bhargava (2005) tested four plant extracts *i.e.* neem seed extract (*Azadirachta indica*), undi extract (*Calophyllum inophyllum*), karanj extract (*Pongamia glabra* [*P. pinnata*]) and mustard oil *(Brassica juncea)* against *C. maculatus* infesting stored moth bean seeds. All plant extracts caused significant mortality in adults after three days of treatment. The neem seed extract at 1.0 ml/100 g seeds was found to be most effective, causing 49.17% mortality of adults. The mean mortality varied from 37.47 to 49.17% in different oils at the highest dose level of 1.0 ml/100 g seeds. Neem seed extract at 1.0 ml/100 g seed was the most effective in inhibiting the oviposition (21.67 eggs/female) compared with 82.67 eggs/female in untreated seeds. At 1.0 ml/100 g seeds, karanj extract caused maximum reduction in egg viability, followed by neem seed extract (64.58%), undi extract (51.72%) and mustard oil (48.52%). The longevity of both the sexes decreased with the increase in doses of plant extracts. No adverse effect of plant extracts was observed on the germination of moth bean seeds up to 90 days of treatme

Gundannavar and Deshpande (2006) studied the effects of neem (*Azadirachta indica)* leaf powder (5%), sweet flag (*Acorus calamus)* leaf powder (1%) and ash (30%) for seed treatment on the incidence of *C. chinensis* and on the quality of seeds of 3 soyabean genotypes (JS 335, MACS-450 and Bragg). Among the cultivars, JS-335 recorded the highest initial germination percentage (94.00-94.67%), root length (18.75-19.05 cm) and vigour index (3567.70-3622.27). The treatments significantly enhanced seed germination and seedling growth in all cultivars. Among the cultivar x seed treatment interactions, JS 335 seeds treated with neem leaf powder and ash registered the highest germination percentage (88.33% for both). Sweet flag leaf powder and ash reduced the population of *C. chinensis* without adversely affecting the seed quality.

Laxmi and Venugopal (2007) found that the seed powders of *Vitex negundo*, *Acorus calamus* and *Curcuma longa* at 3%, palmarosa (*Cymbopogon martinii*) spike powder at 3%, neem kernel dust at 3%, activated clay at 1%, Teepol at 0.1% and seed and leaf powders of *Annona squamosa* at 3% did not affect the germination of green gram seeds.

2.5 Effect on Proximate Analysis

Gupat *et al.* (1981) reported an increase in protein content from 16.4 to 32.8 percent in 4 percent weevilled kernel on the Bengal gram. The increase in protein content was due to the fact that grubs of *C. maculate* .Feed on endospermic portion which contain minimum percentage of protein whereas, greater part of protein were found in the bran which was undamaged. Therefore, on weight basis the damage pulses were found contain higher percentage of protein.

Doharey *et al*.(1983) evaluated qualitative losses in green gram caused by C. *chinensis* L. during storage.The estimated 22.15 to 22.34 per cent protein in control as against 22.15 to 47.14 per cent in stored moong after 120 days of infestation. The increase in protein content was postulated due to increase in uric acid. Insect fragments and respiratory loss of carbohydrate.

Modgil and Mehta (1994) studied that the effect of insect infestations on pysico-chemical propertiese, energy value, true protein, non protein nitrogen, methionine and uric acid content in green grain and red gram with the increase in infestation, a significantly increase in uric acid manifold. Thus, the qualitative and quantitative damage to grains related to the extend of infestation and such grain should be avoided for human consumption.

Modgil and Mehta (1995) evaluated the physico-chemical change in benagal gram(Cicer ariretinum) infestated by *callosobruchus chinensis* L. and stored for 6 months with increase storage period,insect infestation increased resulting in a decrease in weight,density embedded larve protein and metionine contents,while all other components (moisture,ash, crude fiber, crude protein, crude fat,non-protein nitrogen and uric acid contents) increased. The changes in these parameters were significant as compared to control samples and were highest at the end of the storage period.

Modgil and Mehta (1996) studied effect of graded level of *Callosobruchus chinensis* L. infestation on the physic-chemical parameters, protein efficiency ratio, feed efficiency ratio, net protein ratio and protein retention efficiency of Bangal gram (chickpeas cicer ariretinum), with increase in the level of infestation, significatnt,increase in all parameters. The insect infested Bengal gram were damaged qualitative as well as quantitatively.

Modgil and Mehta (1997) studied effect of *Callosobruchus chinensis* (L.) infestation was seen on the carbohydrate and dietary fibre content of chickpea, green gram and pigeon pea at 10, 20, 30, 40, 50 and 60 per cent levels of infestation. With increase in level of infestation energy, starch, total sugars and non-reducing sugars decreased, whereas significant increase in the reducing sugars, crude fibre, neutral detergent fibre, acid detergent fibre, hemicellulose, cellulose and lignin was observed.

Shaw (1998) studied some quantitative and qualitative effect on green gram stored under condition of different initial grain moisture content, storage period and storage containers. Green gram (*Vigna Radiate* L.) seeds at 8,12 and 16 percent moisture contents were stored for up to 180 days in polythene or jute bags. Moisture contents,intake (C.*chinensis)* damage. Seed weight, protein content and nitrogen solubility index are tabulated. Storage in polythene bags gave better seed preservation than jute bag.

Saxena and saxena (2011) studied effect on chemical composition of chickpea seeds treated with three plants extracts namely, *Azadirachta indica*(kernels), *Allium satium* (bulb) and *Piper nigrum* (seeds) after infestation with three pairs of cowpeaweevil, *Callosobruchus maculatus*, had been evaluated after one month. The seeds were also taken for analysis of nutritional changes from culture infested with *C. maculatus* after one and six months of infection. An increase in total ash and protein content has been noticed while crude fat (ether extract) and total carbohydrate decreases with increased weevilisation in chickpea (*Cicer arietinum*) seeds. No significant change in nutritional component has been found in seeds treated with petroleum ether extract of neem kernels, garlic bulb and black pepper seeds, however, statistical analysis showedsignificant difference in biochemical components of infected and normal seeds.

CHAPTER 3

MATERIAL AND METHODS

The present study "Bio-efficacy of some edible oils and plant products for managing pulse beetle, *Callosobruchus chinensis* (Coleoptera: Bruchidae) in stored green gram" was conducted under laboratory conditions at Post Harvest Technology Scheme, Department of Processing and Food Engineering, College of Technology & Engineering, Udaipur during 2013-14 with the following objectives.

- To evaluate the bio-efficacy of edible oils and plant products against pulse beetle.
- To determine the effect of edible oils and plant products on the proximate value of green gram.
- To observe the effect of edible oils and plant products on the colour value and germination of green gram.

The details of materials used and methods adopted during the course of investigation have been presented as under:

3.1 Procurement of Experimental Material

The study was conducted on green gram seed included three insecticides botanicals plant material *i.e.* dried powder of papaya leaves, leamon leaves & neem leaves and three edible oil *i.e.* sesame oil, groundnut oil & mustard oil .Different eighteen combinations of treatments and untreated control constituting nineteen treatments with three different concentrations in 100 g sample, laid out in Factorial RBD design.

3.1.1 Green gram seed

The study was conducted on green gram seeds (var. Pusa Baisakhi) procured from the CTAE instructional farm. The initial moisture content of green gram was 11.44% wb, after cleaning and grading samples were placed in properly sealed Jute bag.Polylined Jute bag were used to avoid insect infestation from the surrounding. Seeds were kept in ambient condition in Post Harvest Technology Scheme, Department of Processing and Food Engineering, Udaipur.

A. Measurment of moisture content

Moisture content of fresh as well as shade dried leaves sample was determined by using AOAC (1984) method. A brief description of the method is as follows.

1. A small sample of leaves was kept in a pre-dried and weighed moisture box. The mass of sample was recorded.
2. The box was placed into a oven mentioned at 70°C temperature for 18 hour.
3. After drying the sample was cooled in a desiccators to room temperature and then weighted.

Moisture content of the sample was calculated by using following equation:

$$MC_{wb}(\%) = \frac{Ww}{Ww+Wd} X100 \qquad \text{……… … (3.1)}$$

Where,

W_d = weight of dry matter (g)

W_w = weight of water (g)

MC_{wb} = moisture content wet basis (%)

3.1.2 Sample Preparation of Test Plants

The plant materials (papaya leaves, lemon leaves & neem leaves) were collected from department of Horticulture, RCA, Udaipur. Initial moisture content of green leaves was measured (AOAC,1980).Then they were shade dried till moisture content reaches safe level 9% (w.b). The initial moisture content (w.b) in papaya leaves, neem leaves and lemon leaves was 92 ,80 and 87 per cent found, respectively. Then these leaves were subjected to shade drying. The resulting dried leaves had 9 %$MC_{wb.}$ The dried leaves were pulverized into fine powder by mechanical grinder and sieving through a mesh size of 50. Leaves powder was placed in airtight polyethylen bags. Stored in cool dry place until they used. (Plate 3.1).

3.1.3 Sample Preparation of Test Oils

The tested edible oils commonly in use were selected for this study (sesame oil, groundnut oil and mustard oil) free from preserving substance, were procured from the local market (Plate 3.1). The edible oils were stored in sealed containers and kept at room temperature at PHT laboratory

Plate 3.1 Experimental edible oils and plant product

3.1.4 Test Insects and Maintenance:

The pulse beetle *C. chinensis* (Coleoptera: Bruchidae) were used for the experiment. The pulse beetle culture (Plate 3.2) for all the studies was maintained in the incubator at constant temperature of 30 ±2^{O}C and 70±5 % relative humidity in the, Post harvest Technology Scheme, College of Technology & Engineering, Udaipur.

The nucleus culture of *C. chinensis* was started from a single pair and was multiplied in rearing jars (25 cm x 15 cm x 10 cm) by releasing 10 pairs of one day old adults in each glass jar containing 500 g seeds for oviposition. After 48 hrs adults were remove from the jars and discarded. The jars were covered with muslin cloth and tied up with rubber bands. These jars were kept at ambient condition in the laboratory. In order to get a continuous fresh supply of adults of *C. chinensis* for experimentation dated culture was maintained at regular time intervals using the above rearing technique. During experimentation a pair of forceps, Camel hair brush and Aspirator (Plate 3.3) was invariably used for transferring insects in seeds.

Plate 3.2. Stock culture of pulse beetle

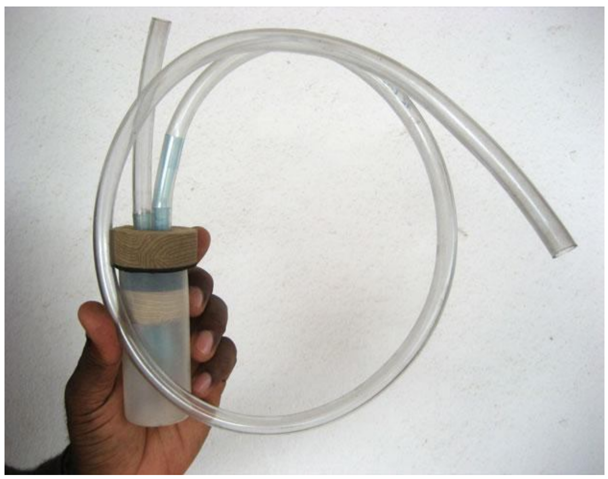

Plate 3.3 Aspirator

1) Rearing of test Insect:

The distinguishing features of the male and female of pulse beetle (Pandy and Singh, 1997) are given below (Table 3.1).

Table 3.1: Distinguishing characters of male and female adults of *C. chinensis*

Features	Male	Female
Size	Average 2.5 x 2.0 mm broad	3.5 x 2.5
Antennae	Pectinate	Serrate
Elytra	1. With deep vertical and closed stripes. 2. With light dark bands expanding laterally and tapering in the mid-dorsal line (usually two bands)	Stripe present No such transverse dark band present
Pygidium	Broad, shiny area spreading over the lateral margin of posterior mid-dorsum, giving shape of expanded inverted „V	Narrow, shiny area confined to the posterior mid dorsum, giving a shape of closed inverted „V

3.2 Effect of edible oils:

Three edible oils (sesame oil, groundnut oil and mustard oil) were evaluated for their effectiveness against pulse beetle under laboratory conditions.

The edible oils (Table:3.2) were procured and were used directly admixture to the grains at application rates of 3,6 & 9 ml/kg of seeds. Each plastic jar was provided with 100 gm sieved grain of green gram (host) which was obtained from market and was subjected to fumigation prior to their use in the experiments by using phostoxin for two weeks so as to kill any pest already existing. Each plant powder was put in separate jar in three replication, which were placed on a mechanical rotary shaker for 10 minutes to thoroughly mixed with grains and then 10 pair of 1-3 day old adult of pulse beetle taken from the 'pulse beetle rearing cell' were released in every jar. The mouth of jar was covered with muslin cloth and secured by rim of lid so as to disallow the entry or exit of any insect. The jars were placed in the incubator at temperature of 30 ± 2^{O}C and 70 ± 5 % relative humidity. Three jars were also placed in the incubator as the control, having grains and pulse beetle adult like jar of above treatments but without any edible oil.

The potency of edible oils will be studied against pulse beetle to the parameters already mentioned in the table: 3.2

Layout of experiment

Number of treatment : 10 (Ten)

Experimental design : Completely Randomized Design

No of replication : 3 (Three)

Table:3. 2. Different edible oils investigated for their bio-efficacy:

S. No.	Dose (ml/kg seed)	Name of the plant	Botanical name
1.	3	Mustard oil	*Brassica campestris* L.
2.	6	Mustard oil	*Brassica campestris* L.
3.	9	Mustard oil	*Brassica campestris* L.
4.	3	Groundnut oil	*Arachis hypogea* L.
5.	6	Groundnut oil	*Arachis hypogea* L.
6.	9	Groundnut oil	*Arachis hypogea* L.
7.	3	Sesame oil	*Sesamum indicum* L.
8.	6	Sesame oil	*Sesamum indicum* L.
9.	9	Sesame oil	*Sesamum indicum* L.
10.	Control		---

The edible oils will be studied against pulse beetle to the following parameters

1. **Mortality of pulse beetle at different time intervals**
2. **Numbers of eggs/seed**
3. **Deterrency (%)**
4. **Numbers of holes/seed**
5. **Weight loss (%) of grains**

Plate 3.4 Experimental Setup (Edible oil)

3.2.1 Mortality of pulse beetle at different time intervals

To assess the efficacy of the plant products, the bruchid adults were released in jars containing seeds of green gram. The jars were filled with treated green gram and left for 24h and then five pairs of 48 h old bruchids were introduced into each jar. The jars were closed with muslin cloth for proper ventilation. The numbers of dead bruchids in each jar were counted after 24, 48 and 72 h.

3.2.2. Numbers of eggs/seed

Average number of eggs per grain laid by Pulse Beetle was calculated to check the effect of treatments on its oviposition/fecundity. Ten grains were randomly selected from each replication egg laid on those grains were counted. At the end, their average was calculated to determine number of eggs per grain in each jar.

3.2.3 Deterrency (%)

The inhibition rates (IR) and deterrency were calculated as follows:

$$\text{IR (\%)} = \frac{\text{No. of larvae in control} - \text{Number of larvae in treated sample}}{\text{No. of larvae in control}} \times 100 \quad \textbf{3.2}$$

$$\text{Deterrency (\%)} = \frac{\text{No. of eggs in control} - \text{Number eggs in treated sample}}{\text{No. of eggs in control}} \times 100 \quad \textbf{3.3}$$

3.2.4. Number of holes/seed

Average number of holes per grain due to Pulse Beetle was calculated to check the effect of treatments on its oviposition/fecundity. Ten grains were randomly selected from each replication hole made on those grains were counted. At the end, their average was calculated to determine number of eggs per grain in each jar**.**

3.2.5.Weight loss (%) of grains

The percent weight loss was calculated at the end of experiment (120 days storage) by using the following formula.

$$\% = \frac{-}{\quad} \; 100 \quad \textbf{3.4}$$

3.3 Effect of Plant Materials:

The plant materials (Table:3.3) were collected and shade dry. The powders of these materials were obtained by grinding them dried form separately in a mechanical grinder and by sieving through a mesh size of 50. The resulting powder was used directly admixture to the grains at application rates of 3, 6 & 9 g/kg of seeds. Each plastic jar was provided with 100 g sieved grain of green gram (host) which was obtained from market and was subjected to fumigation prior to their use in the experiments by using phostoxin for two weeks so as to kill any pest already existing. Each plant powder was put in separate jar in three replication, which were placed on a mechanical rotary shaker for 10 minutes to mix plant powder /grain mixture thoroughly with grains and then 10 pair of 1-3 day old adult of pulse beetle taken from the 'pulse beetle rearing cell' were released in every jar. The mouth of jar was covered with muslin cloth and secured by rim of lid so as to disallow the entry or exit of any insect. The jars were placed in the incubator at temperature of 30 ± 2^{o}C and 70 ± 5 % relative humidity. Three jars were also placed in the incubator as the control, having grains and pulse beetle adult like jar of above treatments but without any plant material.

Table.3.3 Different treatment investigated for their bio-efficacy

S. No.	Dose (g/kg seed)	Common name	Scientific name
1.	3	Papaya leaves	*Carica papaya* L.
2.	6	Papaya leaves	*Carica papaya* L.
3.	9	Papaya leaves	*Carica papaya* L.
4.	3	Lemon leaves	*Citrus limonium*
5.	6	Lemon leaves	*Citrus limonium*
6.	9	Lemon leaves	*Citrus limonium*
7.	3	Neem leaves	*Azadiracta indica*
8.	6	Neem leaves	*Azadiracta indica*
9	9	Neem leaves	*Azadiracta indica*
10.	Control		----

Plate 3.5 Experimental Set up (Plant products)

The insecticidal potency of the plant powders against pulse beetle will be studied to the following parameters:

1. **Mortality of pulse beetle at different time intervals**
2. **Numbers of eggs/seed**
3. **Deterrency (%)**
4. **Numbers of holes/seed**
5. **Weight loss (%) of grains**

3.3.1. Mortality of pulse beetle at different time intervals

To assess the efficacy of the edible oils, the bruchids adults were released in jars containing seeds of green gram. The jars were filled with treated green gram and left for 24h and then five pairs of 48 h old bruchids were introduced into each jar. The jars were closed with muslin cloth for proper ventilation. The numbers of dead bruchids in each jar were counted after 24, 48 and 72 h.

3.3.2. Numbers of eggs/seed

Average number of eggs per grain laid by Pulse Beetle was calculated to check the effect of treatments on its oviposition / fecundity. Ten grains were randomly selected from each replication egg laid on those grains were counted. At the end, their average was calculated to determine number of eggs per grain in each jar.

3.3.3 Deterrency(%)

The inhibition rates (IR) and deterrency were calculated as follows:

$$\text{IR (\%)} = \frac{\text{No .of larvae in control} - \text{Number of larvae in treated sample}}{\text{No.of larvae in control}} \times 100 \quad \textbf{3.2}$$

$$\text{Deterrency (\%)} = \frac{\text{No .of eggs in control} - \text{Number eggs in treated sample}}{\text{No.of eggs in control}} \times 100 \quad \textbf{3.3}$$

3.3.4. Number of holes/seed

Average number of holes per grain due to Pulse Beetle was calculated to check the effect of treatments on its oviposition/fecundity. Ten grains were randomly selected from each replication hole made on those grains were counted. At the end, their average was calculated to determine number of eggs per grain in each jar.

3.3.5.Weight loss (%)

The percent weight loss was calculated at the end of experiment (120 days storage) by using the following equation.

$$\text{Weight loss \%} = \frac{\text{Initial weight} - \text{Weight of sound and damaged grains}}{\text{Initial weight}} \times 100 \quad \textbf{3.4}$$

3.4 Quality Analysis

Quality is main parameter for consumer acceptance. Quality of treated seeds with different edible oils and plant product was analyzed after 120 days of application. Quality parameters were seed germination ,bio-chemical analysis(fat, protein and carbohydrate) and color was determined**.**

3.4.1 Effect on germination

The effect of tested plant products and edible oil were observed on the germination of green gram seeds at 0, 30, 60, 90 and 120 days interval. The seeds were treated with plant products (3,6 &9g/kg seeds) and edible oils (3,6&9ml/kg seeds) replicated thrice and stored in jars. The germination tests were carried out according to International Rules of Seed Testing (Anonymous, 1976). Hundred seeds from each replication were placed in a petri dish (diameter 15 cm) having blotting paper moistened with distilled water. The petri dishes were kept at a temperature of 28 ± 2^{O}C. On eighth day of germination test, number of normal seedlings were counted and expressed as germination percentage.

3.4.2 Colour measurement

Colour is one of the most important qualities of acceptance for products, reflects sensation to the human eye. Colour is important to consumer as a mean of identification, as a method of judging quality and for its basic aesthetic value. The colorimeter used in the present investigation is Hunter Lab Colorimeter (Model CFLX/DIFF, CFLX-45) is shown in Plate 3.6

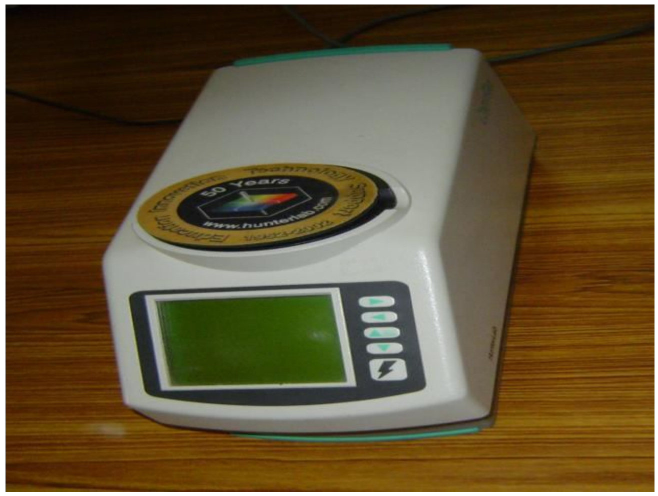

Plate 3.6 Hunter lab colorimeter

. A cylindrical glass sample cup (63.5 mm in diameter x 40 mm height) was placed at the light port (31.75 mm diameter). The instrument was initially calibrated with a black as well as with standard white plate supplied with the equipment. The 3-dimensional scale L*, a* and b* were used in a Hunter Lab Colorimeter.

Plate 3.7 Colour Scale representing relationship of colour index (L*, a*, b*)

- The L* is the lightness coefficient, ranging from 0 (black) to 100 (white) on a vertical axis.
- a* measure redness when positive, gray when zero and greenness when negative.
- b* measures yellowness when positive,gray when zero and blueness when negative. (Plate 3.7). Hunter L-value, which denotes the degree of whiteness, was chosen to represent the colour value of sample.

3.4.3 Proximate analysis of green gram

The effect of edible oils and plant products on total carbohydrate, total protein and crude fat were measured using the standard procedures, respectively, by Anthrone method (Sadasivam and Manickam, 1992), Kjeldahl method and sohxlet (AOAC, 1965).

Preparation of Sample

For determining the effect on proximate value of green gram, each plastic jar was provided with 100 gm sieved grain. Each edible oil and plant powder was put in separate jar in three replication at their three doses. Then were transferred on a mechanical rotary shaker for 10 minutes to thoroughly mixed with grains.The mouth of jar was covered with muslin cloth and secured by rim of lid so as to disallow the entry of any insect. The jars were placed in the incubator at temperature of 30 ± 2^{o}C and 70 ± 5 % relative humidity. Three jars were also placed in the incubator as the control, having grains but without any edible oil or plant product treatment. Then these were opened after 120 days of storage.

For determining fat,carbohydrate,crude protein content, green grams were grinded in mechanical grinder. Green gram powder sieved though mesh size of 20.

3.4.3.1 Determination of total carbohydrate by Anthrone method

Carbohydrates are the important components of storage and structural materials in the plants. They exist as free sugars and polysaccharides. The basic units of carbohydrates are the monosaccharides, which cannot be split by hydrolysis into more simpler sugars. The carbohydrate content can be measured by hydrolysing the polysaccharides into simple sugars by acid hydrolysis and estimating the resultant monosaccharides.

Principle

Carbohydrates were first hydrolysed into simple sugars using dilute hydrochloric acid. In hot acidic medium glucose was dehydrated to hydroxymethyl furfural. This compound formed with anthrone a green coloured product with an absorption maximum at 630 nm.

Material

- 2.5 N HCl
- *Anthrone reagent:* Dissolve 200 mg anthrone in 100 mL of ice-cold 95% H_2SO_4. Prepared fresh before use.
- *Standard glucose:* Stock—Dissolved100 mg in 100 mL water. Working standard—10 mL of stock diluted to 100 mL with distilled water. Stored refrigerated after adding a few drops of toluene.

Plate 3.8 Pictorial view of Spectrophotometer

Procedure

1. Weighted 100 mg of the sample into a boiling tube.

2. Hydrolysed by keeping it in a boiling water bath for three hours with 5 mL of NHCl and cool to room temperature.
3. Neutralised it with solid sodium carbonate until the effervescence ceases.
4. Made up the volume to 100 mL and centrifuge.
5. Collected the supernatant and took 0.5 and 1 mL aliquots for analysis.
6. Prepared the standards by taking 0, 0.2, 0.4, 0.6, 0.8 and 1 mL of the working standard.„0 served as blank.
7. Made up the volume to 1 mL in all the tubes including the sample tubes by adding distilled water.
8. Then added 4 mL of anthrone reagent.
9. Heated for eight minutes in a boiling water bath.
10. Cooled rapidly and read the green to dark green colour at 630 nm.(Plate 3.7)
11. Drew a standard graph by plotting concentration of the standard on the X-axis versus absorbance on the Y-axis.
12. From the graph calculated the amount of carbohydrate present in the sample tube.

Calculation

Amount of carbohydrate present in 100 mg of the sample

$$= \frac{\text{mg of glucose}}{\text{Volume of test sample}} \times 100 \qquad \textbf{3.5}$$

3.4.3.2. Nitrogen analysis by Micro-kjeldahl method

Pulses are main source of protein. These are the major source of building materials for the body. Proteins also function as biocatalysts. The food value of the protein depends upon the nature and content of its amino acids, which are its structural units. The excess of protein not required for building may be used as a source of energy.

Materials

- Sulphuric acid
- Potassium sulphate and copper sulphate

(catalysts)

- Sodium hydroxide 50% solution
- Indicator solution: Methyl red 0.2g/100ml ethanol, methylene blue
- 0.2g/100ml ethanol. For mixed indicator, two parts of methyl red
- solution were added to one part of methylene blue solution
- Boric acid 2% solution
- Standard HCl or H_2SO_4

Procedure

0.5 g samples (powdered green gram) was weighed and transferred to digestion flasks. 1 mg each of the catalyst was added and the samples were digested with 10 ml of concentrated sulphuric acid till the solution became colourless. After digestion the volume was made to 100 ml with distilled water. From this10 ml of digested and diluted sample(s) was taken in Kjeldahl flask along with10 ml of 50% NaOH and heated to liberate ammonia. The liberated ammonia was collected in a 100ml conical flask containing 5ml of boric acid solution with a few drops of mixed indicator. The flask was placed with the tip of the condenser dipping below the surface of the solution. The solution was titrated against the standard acid until the first appearance of violet colour, the end point. A reagent blank was run with an equal volume of distilled water and the titration volume was subtracted from that of sample titre volume.

Calculation

$$\text{Protein \%} = \frac{\text{Titre reading x Normality of } H_2SO_4 \text{ x 0.28 x Volume made up x 100 x 6.25}}{\text{0.02 x 1000 x aliquat taken x sample taken}} \quad \textbf{3.6}$$

3.4.3.3 Estimation of fat content

Fat is the most concentrated form of energy in the food. It furnishes more than twice the number of calories per gram furnished by carbohydrates or proteins.

Materials

- Petroleum ether (40-160 C)
- Whatman No. 2 filter paper

Procedure

1. 10g green gram seed powder was taken in a folded filter paper which was later closed from all sides.
2. The sample packet was placed in the butt tubes of the Soxhlet extraction apparatus.
3. The sample was extracted with petroleum ether for 6 hours by gentle heating.
4. The apparatus was cooled and the extraction flask was dismantled.
5. The ether was evaporated on water bath until no odor of ether remained.
6. The flask was cooled at room temperature.
7. The flask was cleaned from outside and weighed.
8. Heating was repeated until constant weight was recorded.

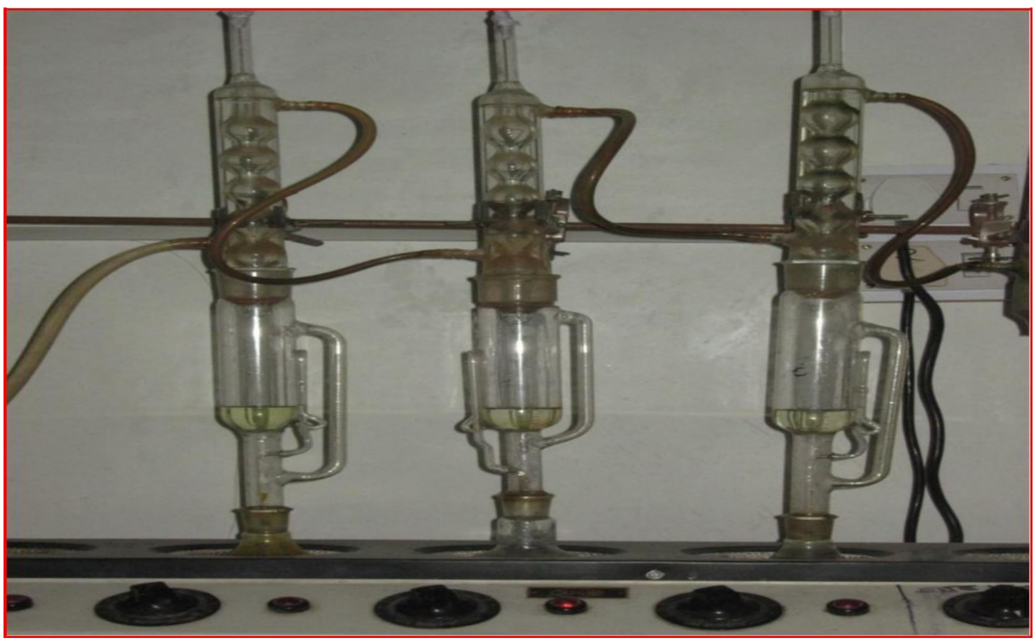

Plate 3 .9 Soxlet Appratus for fat determination

Calculation

$$\text{Fat in the green gram sample (\%)} = \frac{\text{Weight of fat (g)}}{\text{Weight of sample (g)}} \times 100 \qquad \textbf{3.7}$$

3.5 Analysis of data

The data were subjected to statistical analysis of variance using Completely Randomized Design. The data in percentages were transformed in to arcsine values and progeny development values were transformed to square root transformations before statistical analysis.

CHAPTER 4

RESULTS AND DISCUSSION

Pulse beetle attacks grain legumes during both pre and post harvest stages all over the world and causes considerable losses in quality and quantitative. The insects cause loss in weight of grain, decreases germination potential and diminish the market as well as nutritional value of the pulses. Therefore, in the present investigation an attempt was made to study the management of pulse beetle through plant products and edible oils. Green grams were treated with both different edible oils and plant products separately. The keeping qualities like loss in weight, germination, color and proximate analysis (fat, protein and carbohydrate) were studied at different time interval. The results of present study are presented in this chapter in the following section:

4.1 Effect of Edible Oils

The findings of the present study indicate the repellent and deterrent effects of some of the edible oils on ovipositing and weight loss of *C. chinensis.* Varying activity by different edible oils indicate that the pest controlling factors are not uniformly present in every edible oil. Oils have a similar mode of action. Insecticidal oils kill insects on contact by disrupting gas exchange (respiration), cell membrane function or structure. They also kill them by disrupting their feeding on oil covered surfaces. Their toxic action is more physical than chemical and is short-lived.

4.1.1 Mortality of Pulse beetle at different time interval

Mortality of pulse beetle was assessed at different time intervals. The numbers of dead bruchids in each jar were counted after 24, 48 and 72 h.

The data presented in Appendix 2 revealed that all edible oils at all the application rates and time interval significantly caused pulse beetle mortality as compared to control. Variation in pulse beetle mortality with different oil doses are presented in fig. 4.1. It can be seen from fig. that with increase in dose of edible oils, mortality of pulse beetle also increased rapidly. Groundnut oil and sesame oil showed (100 %) the maximum mortality at 6 and 9 ml/kg seeds.

These findings are in confirmation with those reported by Khalequazzzaman *et al*.(2007) and Pandey (1978). Pandey who reported that groundnut oil at 0.3 w/w gave complete protection of green gram against *C. maculatus*. In present study, the minimum (92%) mortality was observed in seeds treated with mustard oil at 3 ml/kg seeds. The application of edible oils at different rates exerted marked effect on the mortality but at higher rates caused rapid mortality. However, more effective oils like groundnut and sesame oil at their higher application rates (9ml/kg seed) provided higher mortalities as compared to mustard oil.

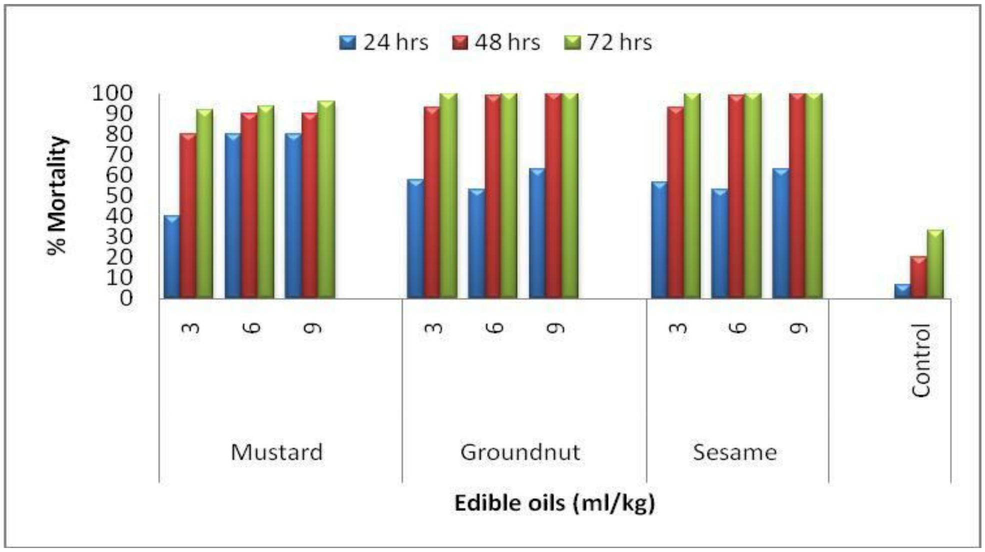

Fig. 4.1 Variation in mortality with different edible oil treatments at different time intervals

Table 4.1: Analysis of variance for effect of edible oils on the mortality of pulse beetle at different time interval

Source of variation	D.F.	24 h			48 h			72 h		
		SS	MSS	F	SS	MSS	F	SS	MSS	F
Treatment	9.00	5159.9	573.33	173.31**	9814.74	1090.53	93.16**	7927.89	880.88	74.34**
Error	20.00	66.16	3.31		234.12	11.71		237.00	11.85	
C.V. %				3.76			4.64			4.27

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant

Similarly, Sujata and Punaiaii (1985) reported that green gram seeds can be protected by treated with groundnut and sesame oil at 0.5 ml/kg seeds. ANOVA was carried out to study the effect of treatment on seeds and the same is presented in

Table.4.1. Edible oil treatment has significant effect on pulse mortality at different time interval at 1 % level of significance.

4.1.2 Number of eggs per seed

To determine number of egg/seed, ten grains were randomly selected from each replication, egg laid on those grains were counted. At the end, their average was calculated to determine number of eggs per grain in each jar. As data presented in Appendix 3 the eggs laid by female on the green gram seeds were significantly less in comparison to untreated control. This is due to the oil layer around treated seeds.

Eggs cannot be attached effectively to the seed surface. The increase in application rates of all the edible oils (3,6 and 9 ml/kg seed) results in decrease in egg laying by pulse beetle, has been reported in all the tested oils significantly as compared to control. This is also presented in fig. 4.2. It clear from fig. that the maximum number of eggs (0.30 egg/seed) were recorded on grain treated with groundnut and sesame oil (9ml/kg seeds). The mustard oil was found least effective (1.20 eggs/seed) at the dose level of 3 ml/kg seeds.

The present observations corroborate with those of Satyavir (2005) and Singh (2003). The reason behind the least effectiveness of mustard oil may be due to the presence of triglycerides, are directly correlated with the insecticidal properties. Data were statically analyzed and ANOVA is presented in Table 4.2. Edible oil treatment has significant effect on no of eggs/hole at 1 % level of significance.

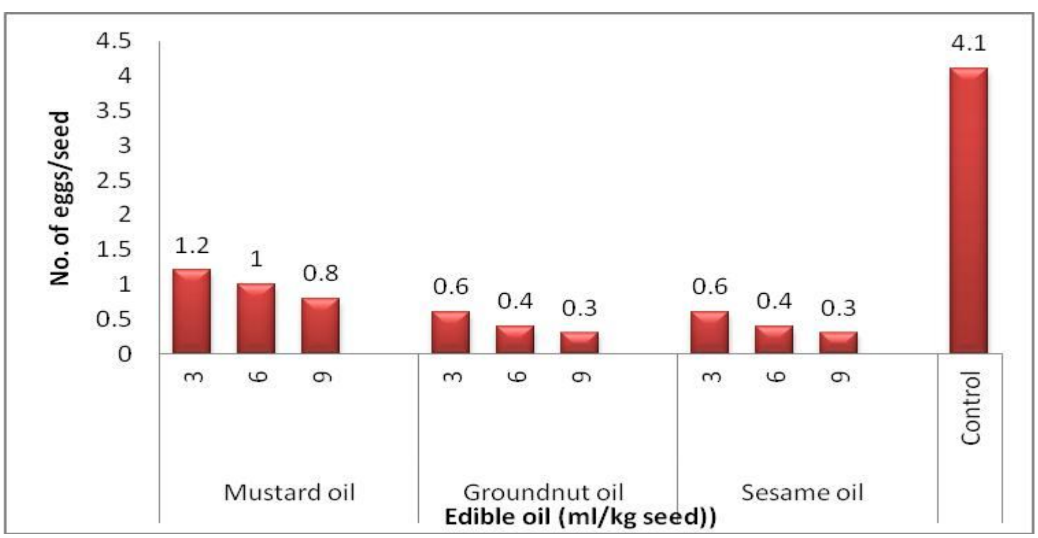

Fig 4.2 Variation in no. of egg with different edible oil treatments

Table 4.2: Analysis of variance for effect of edible oils on different parameter of pulse beetle

Source of variation	D.F	No. of eggs/seed			Deterrency			No. of holes/ grain			Per cent weight loss of grain		
		SS	MSS	F	SS	MSS	F	SS	MSS	F	SS	MSS	F
Treatment	9.00	3.79	0.42	1598.58**	13335.54	1481.73	171.44**	0.81	0.09	2490.97**	2895.29	321.70	2657.74**
Error	20.00	0.01	0.00		172.86	8.64		0.00	0.00		2.42	0.12	
C.V. %				**1.40**			**4.81**			**0.71**			**2.43**

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant

4.1.3 Deterrency (%)

Deterrency (%) was evaluated by using the equation 3.3 in pre described chapter 3. Data presented in Appendix 3 taken during experimentation. Data revealed that all the treatments were found effective in decreasing eggs laying. The data are also shown in graphical formation in fig.4.3. It can be observed from fig. that the higher doses (9ml/kg seed) were found more effective as compared to lower doses (3 and 6 ml/kg seed).Green gram seeds treated with groundnut and sesame oil at 9ml/kg exhibited the maximum deterrency (92.73%) followed by groundnut and sesame oil % 6 ml/kg seeds (90.31%). The minimum (70.94%) deterrency was exhibited by mustard oil (3 ml/kg seed).

Similar results were found by Rahaman and Tendulkar (2006) and Sharma and Shivastva (1984). They reported 90.00 per cent reduction in oviposition deterrency by the groundnut oil treatment. Ibrahim (2012), who reported 98.49 per cent oviposition deterrency of sesame oil at 5 and 7.70 ml/kg seeds. Rajkapse *et al.*(1997) observed similar results, while investigating the efficacy of edible oils.

Data were statically analyzed and ANOVA is presented in Table 4.2. Edible oil treatment has significant effect on deterrency (%) at 1 % level of significance.

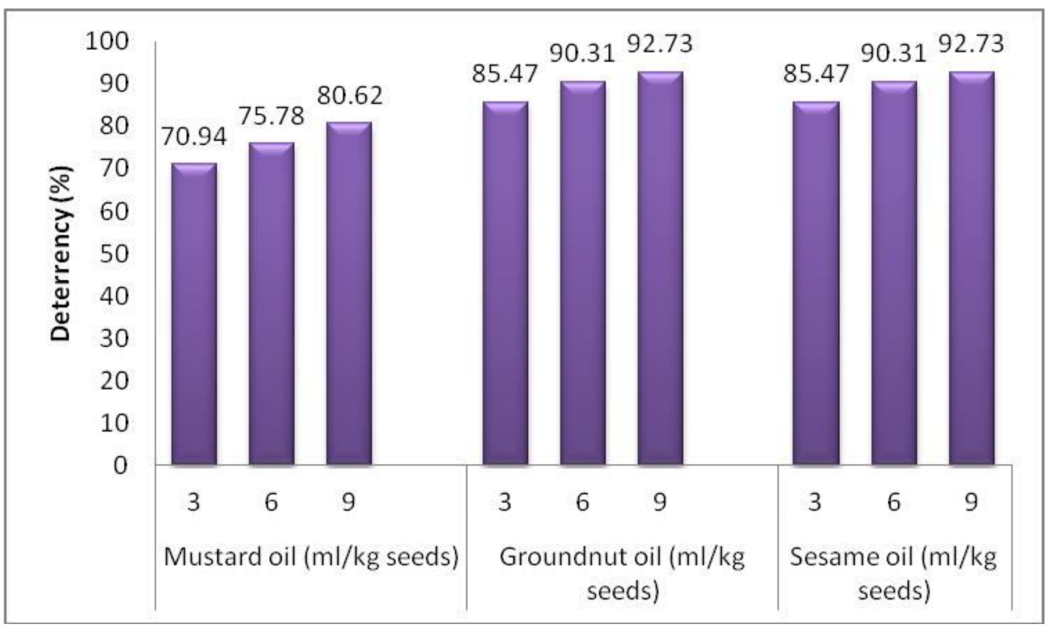

Fig. 4.3 Variation in deterrency with different edible oil treatments

4.1.4 Number of holes per seed

To assess number of hole/seed, ten grains were randomly selected from each replication, hole made on those grains were counted. Then their average was calculated to determine number of eggs per grain in each jar.

The data presented in Appendix 3 showed that all edible oils significantly reduced number of holes made by pulse beetle as compared to the control (1.20 holes /seed). The variation in number of hole/seed with different edible oil treatment is shown in fig. 4.4. It is clear from graph that no hole/seed was recorded in green gram treated with groundnut oil (9ml/kg seed). The maximum (0.30 holes/seed) holes were recorded in seeds treated with mustard oil at 3 ml/kg/seeds.

The work on the effect of edible oils on number of holes made by pulse beetle is not available; hence, the present results could not be compared. Data were statically analyzed and ANOVA is presented in Table 4.2. Edible oil treatment has shown significant effect on holes/seed at 1 % level of significance

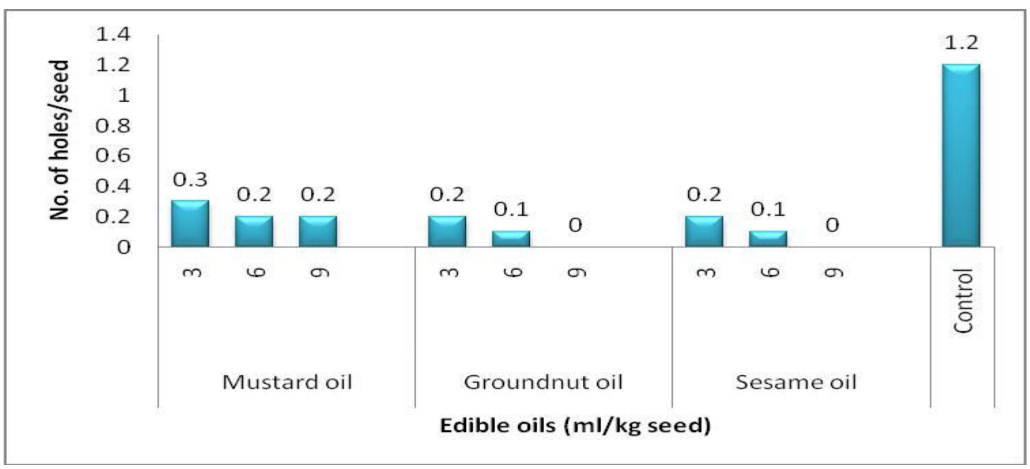

Fig. 4.4 Variation in hole/seed with different edible oil treatments

4.1.5 Weight loss (%)

Weight loss (%) was evaluated by using equation 3.4 in the pre described chapter 3. The effect of edible oil on grain weight loss caused by pulse beetle showed that all the edible oil at all application rates significantly reduced the weight loss caused by pulse beetle when compared with the control . This can be seen from Appendix 3 that minimum weight loss of 1.33 per cent was recorded in ground nut and sesame oil (9ml/kg seed) treated seeds.

These findings are in confirmation with the result of Khalequazzzaman *et al*.(2007).They reported the minimum weight loss in gains achieved by groundnut oil at 1% up to 66 days after treatment . In present study, the maximum weight loss of 45.50 per cent was recorded in the control. This data is also presented in graphical formation in fig. 4.5.

Gujar and Yadav (1978) reported weight loss by a single generation in *C. chinensis was* 30.2 to 55.7 %. However, mustard oil was found least effective in protecting grains from the damage of pulse beetle. Khaire *et al.*(1992) also found similar result working with groundnut and mustard oil @ 1% level up 100 days after treatment. Similar results were observed by Singal(1995). These findings are also in confirmation with Singh *et al*. (1988) who reported that grain treated with refined and crude oil @ 0.5 ml/100gm grain were free from insect damage and without any apparent loss in the grain weight and seed germination.

Data were statically analyzed and ANOVA is presented in Table 4.2. Edible oil treatment has significant effect on weight loss at 1 % level of significance.

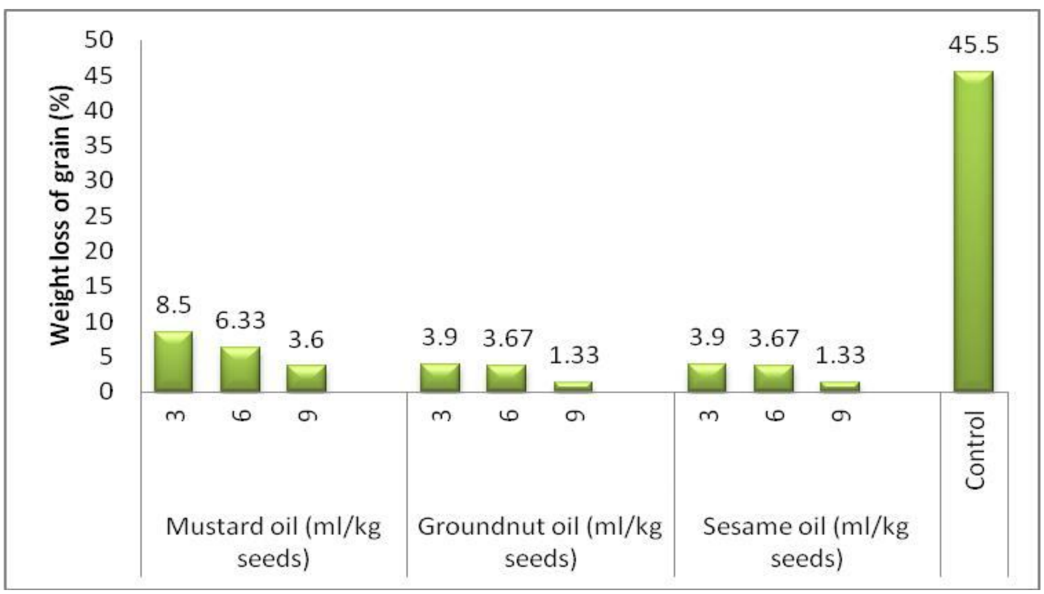

Fig. 4.5 Variation in weight loss with different edible oil treatments

4.2 Effect of Plant Product

The findings of the present study indicate the repellent and deterrent effects of some of the leaf powders on oviposition, fecundity, deterrency and weight loss of *C.*

*chinensis.*Varying activity by different powders indicate that the pest controlling factors are not uniformly present in every plant product.

4.2.1 Mortality of Pulse beetle at different time Interval

Mortality of pulse beetle was assessed at different time intervals. The numbers of dead bruchids in each jar were counted after 24, 48 and 72 hour of treatment.

The data presented in Appendix 4 showed that plant powders at all the application rates and time interval significantly caused pulse beetle mortality as compared to control. Papaya leaf powder showed the maximum of per cent mortality (100 %) at 9 g/kg seed. The minimum (20%) mortality was observed in seeds treated with lemon leaf powder (3 g/kg seed) on 24 hour of treatment. These data are also presented in fig.4.6. It depicted from graph that the application of powders at different rates exerted marked effect on the mortality but at higher rates caused rapid mortality. However, more effective powder like papaya leaf powder and neem leaf powder at their higher application rates (9g/kg seed) provided higher mortalities as compared to lemon leaf powder.

These findings are in confirmation with Mendki *et al.*(2000). They reported that no adult of pulse beetle found in green gram treated with papaya leaf powder at 1 g/kg seeds up to six month. Bajiya *et al.*(2007) also reported 51 per cent mortality of pulse beetle treated with neem leaf powder @ 12.0 g/kg seeds after 3 days of treatment. Similar results were also reported by Shivanna *et al.* (1994), support the present findings.

Data were statically analyzed and ANOVA is presented in Table 4.3. Plant product treatment on green gram seeds has shown significant effect on pulse beetle mortality at 1 % level of significance.

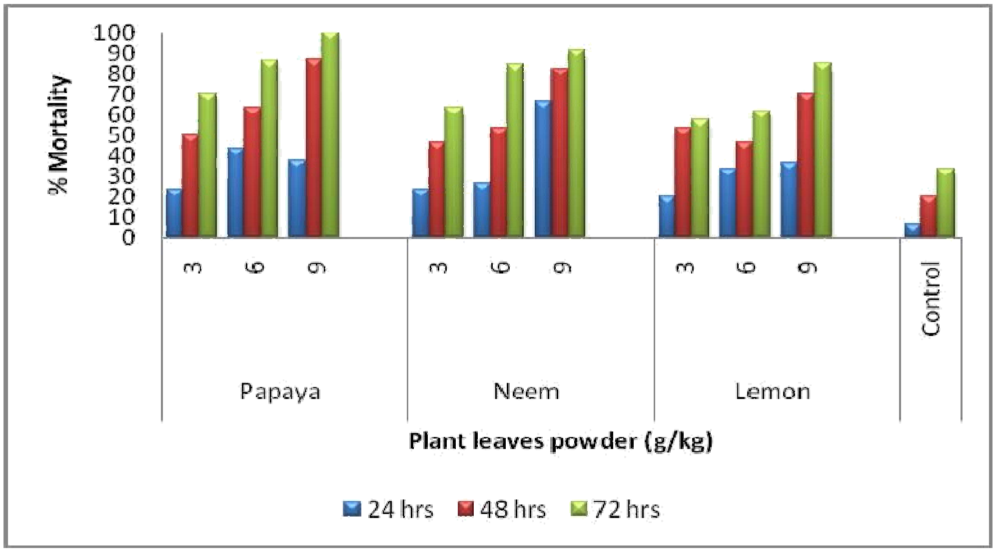

Fig. 4.6 Variation in mortality (%) with different plant products

Table 4.3 Analysis of variance for effect of plant products on the mortality of pulse beetle at different time interval

Source of variation	D.F.	24 h			48 h			72 h		
		SS	MSS	F	SS	MSS	F	SS	MSS	F
Treatment	9.00	2959.82	328.87	333.18**	4031.55	447.95	132.55**	6304.05	700.45	112.28**
Error	20.0	19.74	0.99		67.59	3.38		124.76	6.24	
C.V.%		2.95			3.71			4.07		

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant.

4.2.2 Number of eggs per seed

To determine number of egg/seed, Ten grains were randomly selected from each replication, egg laid on those grains were counted. At the end, their mean was calculated to determine number of eggs per grain in each jar.

As data presented in Appendix 5 show that all the plant product were found effective in reducing the number of eggs laid by pulse beetle as compared with the control. It can be seen from fig.4.7 that the lowest number of eggs (1.20 eggs/seed) were recorded in grain treated with papaya powder followed by neem leaf powder (1.30 eggs/seed). These result are confirmed with Kharare *et al*.(1993).While treating with 1% neem leaf powder .The maximum numbers of eggs (3.0 eggs /seed) were found in lemon leaf treated sample at 3g/kg seed, Similar result was also reported by Kumari and Singh (1998), Supporting the present findings. According to them, Neem leaf powder was equally effective in reducing number of egg laid and mortality. Data were statically analyzed and ANOVA is presented in Table 4.4. The effect on no of eggs laid by pulse beetle was significant at 1% level of significance.

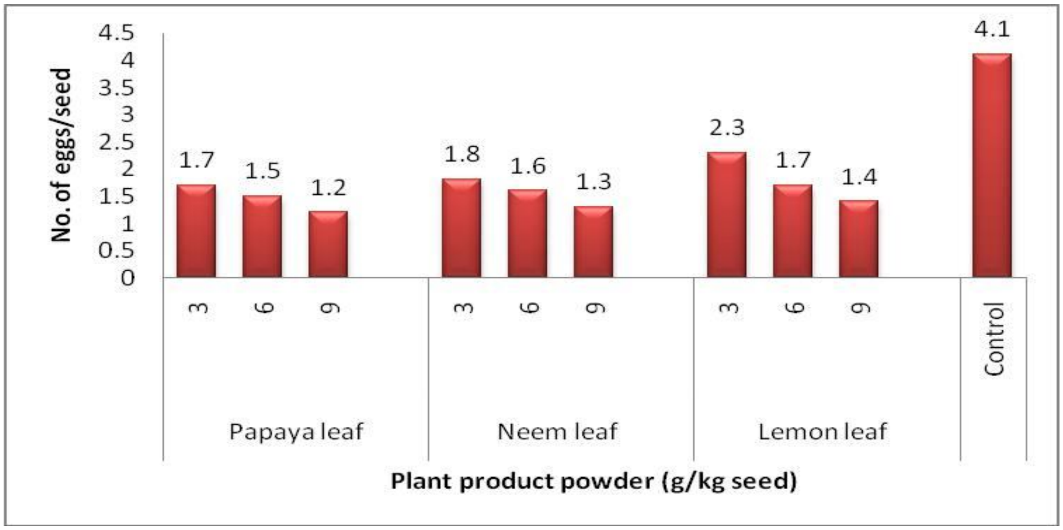

Fig.4.7 Variation in number of egg/seed with different plant product

4.2.3 Deterrency (%)

Deterrency (%) was evaluated by using the equation 3.6 pre described in chapter 3. Data present in Appendix 5 revealed that all the treatments were found effective in increasing deterrency (%). The higher doses (9ml/kg seed) were found more effective as compared to lower doses (3and 6g/kg seed) .Variation in deterrency is depicted in fig 4.8. It is evident from the fig. that Green gram seeds treated with papaya leaf at 9g/kg seed exhibited the maximum (70.46%) deterrency followed neem leaf powder at 9 g/kg seed (67.55%).The minimum 42.85 per cent deterrency was exhibited by lemon leaf powder.

These results are in confirmation with those reported by Mendki *et al.* (2000). Data were statically analyzed and ANOVA is presented in Table 4.4. The different treatment had shown their significant effect at 1 per cent level of significance

Table 4.4: Analysis of variance for effect of plant products on different parameter of pulse beetle

Source of variation	D.F.	No. of eggs/seed			Deterrency			No. of holes/ grain			Per cent weight loss of grain		
		SS	MSS	F	SS	MSS	F	SS	MSS	F	SS	MSS	F
Treatment	9.00	1.62	0.18	260.04**	7637.82	848.65	335.03**	0.34	0.04	306.20**	1199.14	133.24	390.18**
Error	20.00	0.01	0.00		50.66	2.53		0.00	0.00		6.83	0.34	
C.V. %				1.73			3.45			1.09			2.34

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant.

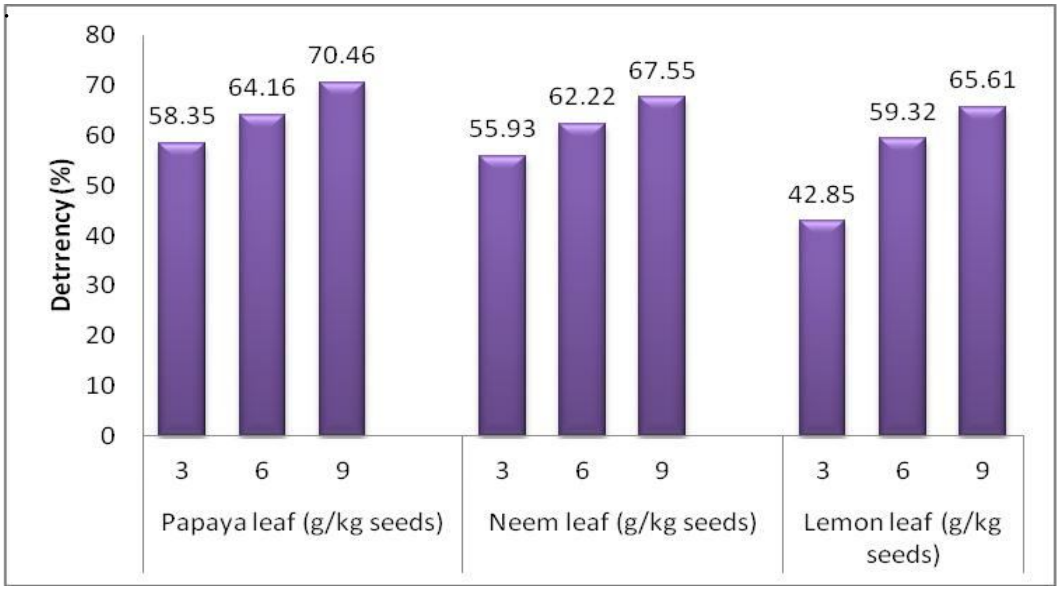

Fig. 4.8 Variation in deterrency with different plant products treatment

4.2.4 Number of holes per seed

To assess number of hole/seed, ten grains were randomly selected from each replication, hole made on those grains were counted. Then their average was calculated to determine number of eggs per grain in each jar. The raw data are presented in Appendix 5 It is revealed from the data, taken during experimentation that all the plant products had reduced number of holes made by pulse beetle as compared to the control. Data are also depicted graphically in fig. 4.9. The minimum number of holes (0.30) was recorded in green gram seeds treated with papaya leaf powder at 9g/kg seeds. The maximum (0.60 holes/seed) numbers of holes were recorded in seeds treated with lemon powder at 3 g/kg seed. The work on the effect of plant product powder on number of holes made by pulse beetle is not available hence; the present results could not be compared. Data were statically analyzed and ANOVA is presented in Table 4.4. These treatments had shown significant effect at 5 and 1 per cent level of significance.

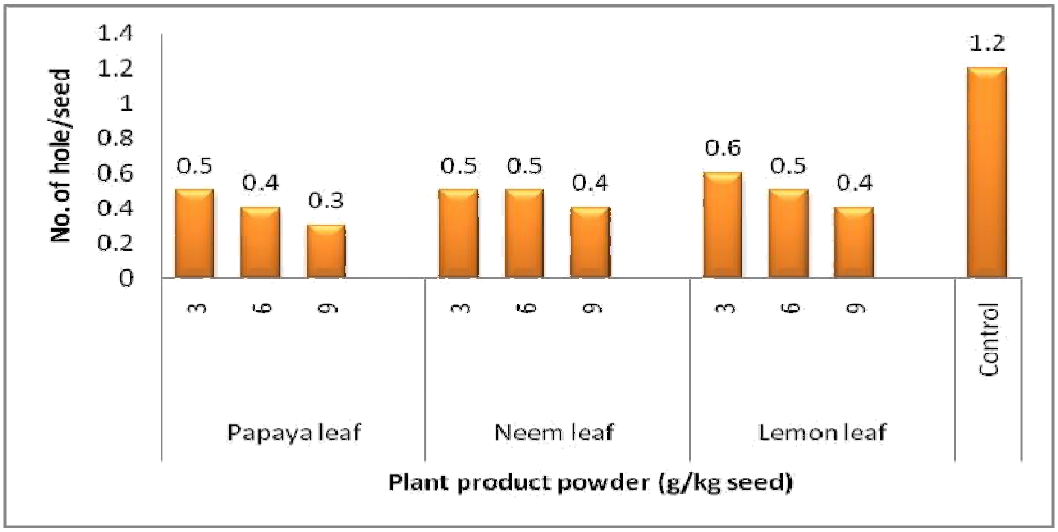

Fig. 4.9 Variation in number of holes with different plant products treatment

4.2.5 Weight loss (%)

Weight loss was determined by using equation 3.7 in chapter 3.The raw data taken during experimental trials is presented in Appendix 5. Variation in weight loss with respect to different plant product is shown in fig. 4.10. It is depicted from fig, the effect of plant products, reduced the weight loss (%) caused by pulse beetle as compared to control .The maximum loss in weight (22.14 %) was recorded in lemon leaf powder at 3g/kg seed. The papaya leaf powder was the most effective (10.80 %) in protecting grains from the damage of pulse beetle when applied at 9 g/kg seed.

These findings are in confirmation with Mendki *et al.* (2000).In present investigation, Seeds treated with neem leaf powder (9 g/kg seed) showed 11.0 per cent loss in weight. These findings are also confirmed with Sharavale *et al.*(1998). They reported 10.78 per cent weight loss found in neem leaf powder treated seeds at 1%. Yogita *et al.(*2001) also found similar results, support the present study. Mishra *et at.*(2000) also reported the similar results for neem leaf powder.

Data were statically analyzed and ANOVA is presented in Table 4.4. These treatments had shown their effect on weight loss (%) at 5 and 1 per cent level of significance.

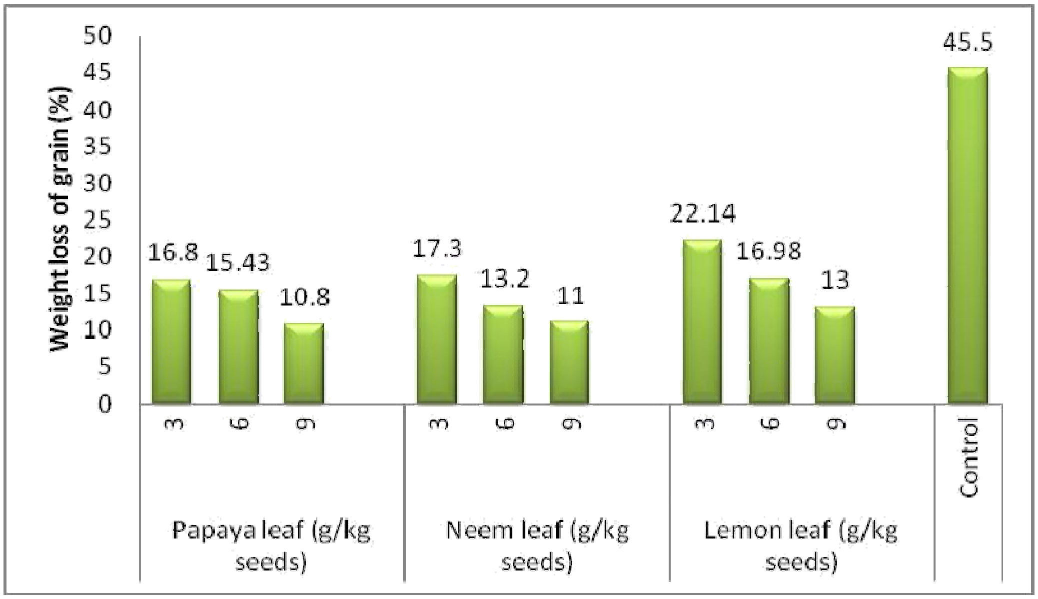

Fig. 4.10 Variation in weight loss with different plant product treatments

4.3 Quality evaluation of Edible oil Treated seed

4.3.1 Effect on the germination

No unfavorable effect on the germination of green gram seeds was observed when treated with different doses of edible oils used as grain protectants at 0, 30, 60, 90 and 120 days after treatment. The data presented in Appendix 6 revealed that at zero day intervals, the germination per cent in all the test compounds range between 92 to 93 and compared to 93.6 in control. At zero days' interval no significant difference among all the treatments were observed. After 30 days of treatment, there was no significant difference on the germination of green gram seeds was observed. However the germination ranged from 91.00 to 92.67 per cent in different treatments as compared to 92.67 per cent in control. (Appendix 6).The germination of green gram seeds ranged from 90.67 to 92.00 per cent after 60 days in different treatment as compared to 92.33 per cent in control (Appendix 6). After 90 days intervals, the germination percentage in all the treatments ranged from 88.67 to 91.00 in different treatments as compared to 91.00 per cent in control (Appendix 6). Likewise 0, 30, 60 and 90 day’s intervals, the germination per cent in all the treatment ranged from 88.00

Table 4.5: Analysis of variance for effect of edible oils on germination of green gram seeds after 0, 30, 60, 90, 1and 120 days of treatment

Source of variation	D.F.	0 DAT			30 DAT			60 DAT			90 DAT			120 DAT		
		SS	MSS	F	SS	MSS	F	SS	MSS	F	SS	MSS	F	SS	MSS	F
Treatment	6	16.8	2.8	0.2[ns]	15.0	2.5	0.2[ns]	4.2	0.7	0.1	18.5	3.08	0.1[ns]	4.7	0.78	0.1[ns]
Error	14	218.02	18.17		170.26	14.19		164.42	13.70		423.59	35.30		100.07	8.34	

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant, DAT= Days after treatment to 89.33 after 120 days of treatment as compared to 89.33 percent in control. However, there was no significant difference among them (Appendix 6) has been observed. While assessing the results, it can safely be said that all the test compounds had no adverse effect on the germination of green gram seeds up to 120 days of treatment.

These findings are in confirmation with Raghvani and Kapadia(2003) and Bhargva and Meena (2002). They reported no adverse effect of tested oils was observed on germination of cowpea seeds up to 150 days of treatment.

Rahman and Tendulkar (2006) also reported no adverse effect on germination even after three month of treatment. Tripathy *et al.* (2001) reported that use of vegetable oils extracts at all concentrations were promising in protecting the seeds. The use of such oils did not affect the germination of the seeds.

Here similarly, Sangwan ,Chhillar and Kashyap (2005) those reported that germination of the seeds treated with different vegetable oils was not affected. Raghvani and Kapadia (2003) reported that that neem and coconut oils @ 10 ml/kg seed provided the complete control of grain against bruchid for six months, The germination of pigeon pea seed not impaired due to different oil treatment even after 6 month of storage period.

Data were statically analyzed and ANOVA is presented in Table 4.5. These treatments had shown non-significant effect for different levels of significance**.**

4.3.2 Effect on Proximate value

The effect of edible oils on total carbohydrate, total protein and crude fat were measured using the standard procedures, respectively, by Anthrone method after 120 day of treatment.

4.3.2.1 Effect of edible oils on fat after 120 days of storage

The related raw data are presented in Appendix 7. The data is also depicted in fig. 4.11. It is clear from fig. that the maximum fat content increase was reported in green gram seeds treated with sesame oil 9 ml/kg seeds. The increased value after 120 days storage was 1.31 g/100 g .In present study with increase in dose (ml/kg seed), fat per cent also increased proportionately. The Least increment was noticed in fat content of groundnut oil treated seed @ 3 ml/kg, after 4 month of storage period. The present findings are confirmed with Modgil and Mehta (1995). They reported increase in crude fat of Bengal gram seeds and a change were at significant as compared to control and was highest at the end of storage period, confirming present results. The increase in fat content in green gram seeds may be due to high fat contents of edible oils.

The increase in fat content has been reported in pigeon pea seeds treated with oils (Anonymous, 2010), support the present findings.

Data were statically analyzed and ANOVA is presented in Table 4.6. The effect of oil on fat content had shown significance at 5 % level of significant.

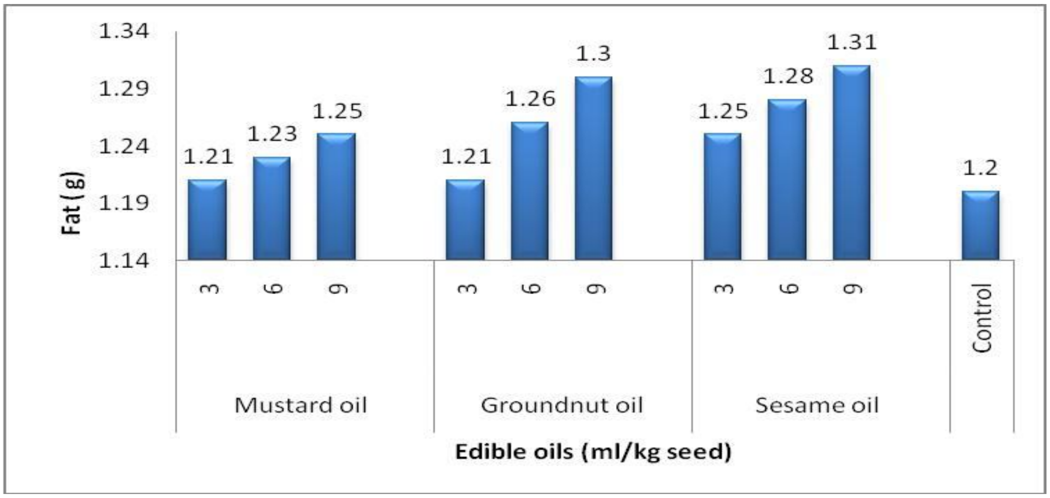

Fig. 4.11 Variation in fat on 120 DAT with different edible oils

Table 4.6: Analysis of variance for fat content in seeds treated with edible oils on 120 DAT

Source of variation	D.F.	SS	MSS	F (cal)
Treatment	9.0000	0.5483	0.0609	2.7720*
Error	20.0000	0.4395	0.0220	
C.V.%				2.30

NOTE: *significant at 5% level of significance,** significant at 1% level of significance, ns-non significant, DAT= Days after treatment.

4.3.2.2 Effect of edible oils on crude protein after 120 days of storage

The related data taken during experimentation are shown in Appendix 8. Data is also depicted in fig.4.12. From fig. it is seen that no considerable variation has occurred in crude protein content of seeds even after 120 DAT treated with edible oils. In control, crude protein rose from 22.15 to 22.34 g/100g. The highest alteration occurred in seeds treated with groundnut oil @ 9ml/kg seeds, it was raised from 22.15 to 22.38 g/ 100g. The minimum increment in protein content was found in seeds, treated with mustard oil @ 3 ml/kg seed. Hence there is no injurious effect on crude protein content had reported, in present investigation. Data were statically analyzed and ANOVA is presented in Table 4.7. This increment in protein had shown non-significant at different levels of significance.

These findings are in confirmation with Modgil and Mehta (2005). Gupta *et al.* (1984), while conducting similar types of studies also concluded that total ash and protein increased in infected seeds of black gram and similar reports has also been shown for pigeon pea by Srivastava *et al.* (1988). Contrary, Khairnar *et al.(*1996) found significant decrease in crude protein content of pigeon pea seeds during storage.

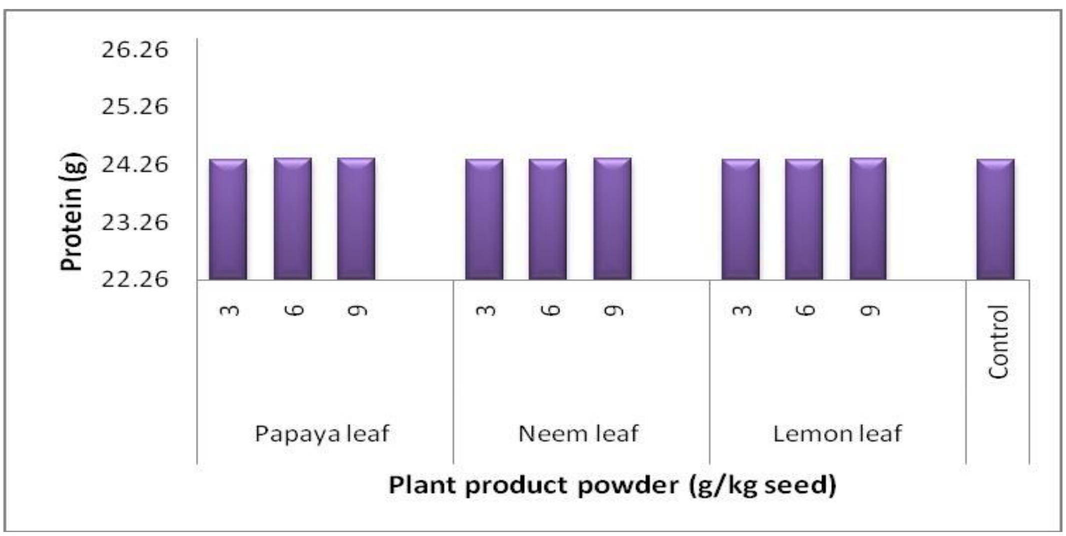

Fig. 4.12 Variation in protein on 120 DAT with different edible oils

Table 4.7: Analysis of variance for protein content in seeds treated with edible oils on 120 DAT

Source of variation	D.F.	SS	MSS	F (cal)
Treatment	9.0000	0.0077	0.0009	0.0017^{ns}
Error	20.0000	9.9396	0.4970	
C.V.%				2.50

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant, DAT= Days after treatment.

4.3.2.3 Effect of edible oil on carbohydrate content of green gram after four Month of storage

The related raw data taken during experimentation are shown in Appendix 9. Data are also depicted in fig.4.13 also. It evident from fig. that no considerable change has been noticed in carbohydrate content of treated seeds with edible oils at all levels, as compared to control. In present study, no contrary consequences on carbohydrate content of treated green gram seeds with different edible oils, had reported.

Data were statically analyzed and ANOVA is presented in Table 4.8. These treatments have shown their non-significant effect on carbohydrate content of seeds after 120 days of storage.

Table 4.8: Analysis of variance for carbohydrate content in seeds treated with edible oils on 120 DAT

Source of variation	D.F.	SS	MSS	F (cal)
Treatment	9.0000	0.0058	0.0006	0.0003^{ns}
Error	20.0000	44.7614	2.2381	
C.V.%				3.06

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant, DAT= Days after treatment, **C.V. (%)=3.06**

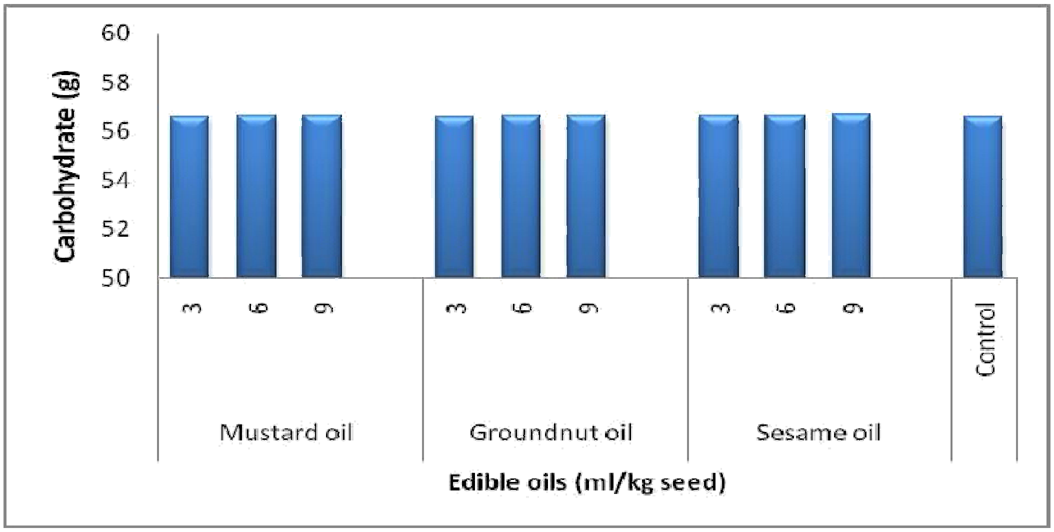

Fig. 4.13 Variation in carbohydrate on 120 DAT with different edible oil

4.4. Quality evaluation of Plant product treated seed

4.4.1 Effect of plant product on the germination of green gram Seeds

No conflicting effect on the germination of green gram seeds was observed when treated with different doses of edible oils used as grain protectants at 0, 30, 60, 90 and 120 days after treatment. The data presented in Appendix 10 revealed that at zero day intervals, the germination per cent in all the test compounds ranged between 91.50 to 93.33 per cent as compared to 93.67 per cent in control. At zero days' interval non significant difference among all the treatments were observed. After 30 days of treatment, there was no significant difference on the germination of green gram seeds was observed. However the germination ranged from 91.00 to 92.33 per cent in different treatments as compared to 92.67 per cent in control. (Appendix 10).The germination of green gram seeds ranged from 90.00 to 92.00 per cent after 60 days in different treatment as compared to 92.33 per cent in control (Appendix 10). After 90 days intervals, the germination percentage in all the treatments ranged from 88.00 to 90.67 in different treatments as compared to 91.00 per cent in control (Appendix 10). Likewise in 0, 30, 60 and 90 days intervals, the germination per cent in all the treatment ranged from 87.33 to 89.33 after 120 days of treatment as compared to 89.33 per cent in control. However, there was no significant difference among them (Appendix 10) has been observed. While assessing the results, it can safely be said that all the test compounds had no adverse effect on the germination of green gram seeds up to 120 days of treatment.

There was no adverse effect of leaf powder on the nutritional quality and per cent germination of five commonly used pulses; viz. soybean, bengal gram, green gram, black gram and red gram. No adult *C. chinensis* were found in pulses treated with leaf powder even after 12 months of treatment have been reported (Mendki *et al.* 2001).

No harmful effect of neem leaf powder at dose level 5.0 per cent on soybean (Gundannavar and Deshpande, 2006) was reported up to 90 days of treatment, support the present investigations.

George (1990) evaluated some plant product @ 10 per cent treatment had shown no adverse effect on germination.

Yadav and Bhargava (2005) reported no adverse effect of plant on the germination of moth bean seeds up to 90 days of treatment.

4.4.2 Effect on Proximate value

4.4.2.1 Effect of plant products on fat content after 120 days of storage

The raw data taken during experimental trials for fat content in tested seeds are shown in Appendix 11 and also depicted in fig. 4.14. The increased fat content ranged from 1.21 to 1.23 g/100g. It is clear from fig. that the plant product powder tested seeds had no variation in fat content even after 120 days of storage period. Fat content after 120 days storage in treated seeds was same as in control (1.2 g/100g).Therefore it could be stated, no adverse effect of these plant products on fat content of green gram seeds after 120 days storage.

These findings are expected also and in confirmation with those reported by Mendki *et al.* (2000). They tested papaya leaf powder at 1 g/kg seed and found no adverse effect on fat content after 180 days of storage on green gram, supporting present study.

Data were statically analyzed and ANOVA is presented in Table 4.10. These treatments had shown no significant level for fat content, showed non significant.

Table 4.9: Analysis of variance for effect of plant product on the germination of green gram seeds after 0, 30, 60, 90, 120, days of treatment

Source of variation	d.f.	0 DAT			30 DAT			60 DAT			90 DAT			120 DAT		
		SS	MSS	F	SS	MSS	F	SS	MSS	F	SS	MSS	F	SS	MSS	F
Treatment	10	41.3	4.1	0.2^{ns}	23.0	2.3	0.1^{ns}	34.3	3.4	0.2^{ns}	43.4	4.3	0.3^{ns}	14.4	1.4	0.1^{ns}
Error	22	366.85	16.68		443.67	20.17		444.92	20.22		309.32	14.06		366.83	16.67	

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant, DAT= Days after treatment

Table 4.10: Analysis of variance for fat content in seeds treated with plant products on 120 DAT

Source of Variation	D.F.	SS	MSS	F (cal)
Treatment	9.0000	0.0255	0.0028	0.1331^{ns}
Error	20.0000	0.4252	0.0213	
C.V.%				2.31

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant, DAT= Days after treatment

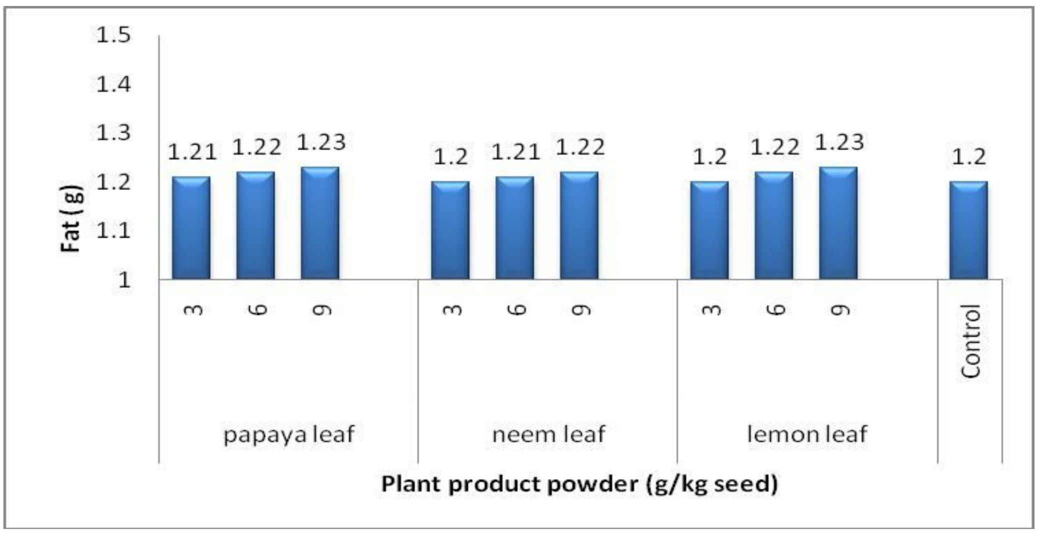

Fig.4.14. Variation in fat on 120 DAT with different plant products

4.4.2.2. Effect of plant products on crude protein after 120 days of storage

The related data taken during experimental trials are shown in Appendix 12. Data are also shown in fig.4.15. It is depicted from fig. that there was no vital variation observed in crude protein content of seeds after 120 days of treatment with plant product. In control, crude protein raised from 22.15 to 22.34 g/100g. Data were statically analyzed and ANOVA is presented in Table 4.11.These treatments had shown no significant effects at different level of significance.

Similar result reported Mendki *et al.* (2000). They tested papaya leaf powder against five commonly used pulses viz., soybean, bengal gram, green gram,, black gram and red gram and found no effect of papaya leaf dusting on the nutritional/Organoleptic quality and per cent germination of pulses.

Table 4.11: Analysis of variance for crude protein content in seeds treated with plant products on 120 DAT

Source of Variation	D.F.	SS	MSS	F (cal)
Treatment	9.0000	0.0014	0.0002	0.0003[ns]
Error	20.0000	9.9387	0.4969	
C.V.%				2.50

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns- non significant, DAT= Days after treatment

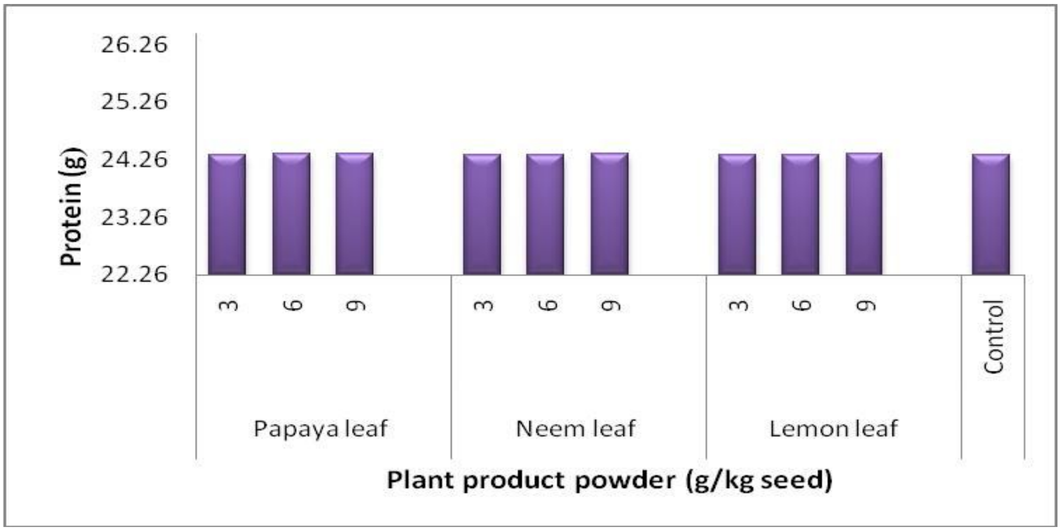

Fig.4.15. Variation in crude protein on 120 DAT with different plant product

4.4.2.3. Effect of plant product on carbohydrate content after 120 days of storage

The raw data taken during experimentation are shown in Appendix 13. Data are also depicted in fig.4.16**.** The increased range of carbohydrate was observed from 56.61 to 56.68 g/100g. It is evident, no significant alteration had been observed in carbohydrate content of treated seeds with plant product at all level, as compared to untreated check. Hence, purpose of experimentation is fulfilled, present study reported, no adverse effect of different plant product treatment on carbohydrate content even after 120 days of treatments.

These findings are in confirmation with Mendki *et al.* (2000). They tested papaya leaf powder at 1 g/kg seed and found no adverse effect on carbohydrate after 180 days of storage on green gram.

Data were statically analyzed and ANOVA is presented in Table 4.12. These treatments had shown no significant effect at different levels of significance

Table 4.12: Analysis of variance for carbohydrate content in seeds treated with plant products on 120 DAT

Source of Variation	D.F.	SS	MSS	F (cal)
Treatment	9.0000	0.0057	0.0006	0.0003^{ns}
Error	20.0000	44.7530	2.2377	
C.V.%				3.06

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant, DAT= Days after treatment

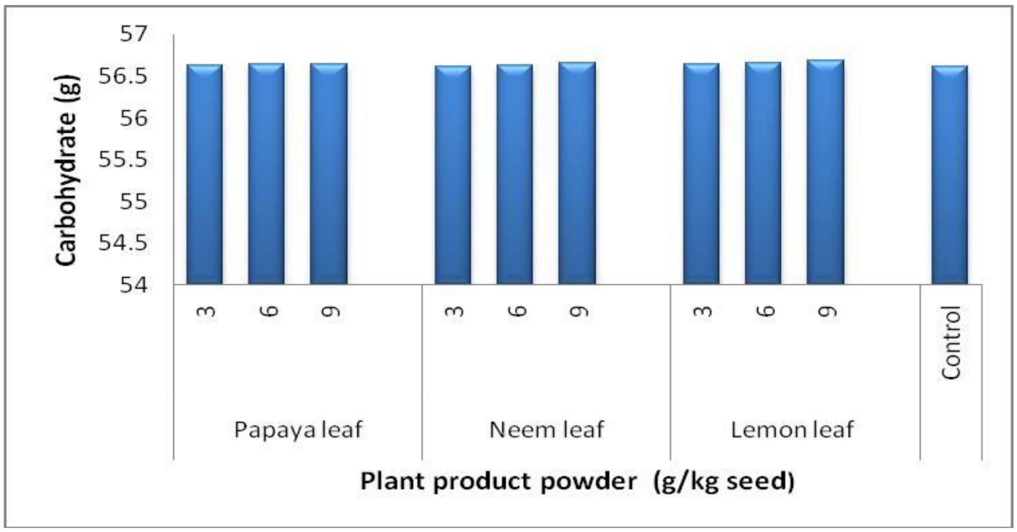

Fig. 4.16 Variation in carbohydrate on 120 DAT with different plant products

4.5. Effect on color values

Colour is often used as a parameter to indicate quality for food products. Hence it has become important for food processors to be able to evaluate quality of their products based on colour. Colour values measured using a colour flex hunter lab colourimeter, were relative to the absolute values of perfect reflecting diffuser as measured under the same geometric conditions.

4.5.1. Effect of edible oils on color value of green gram seeds after 120 days storage

There was no noticeable change found in b* color value of seeds treated with edible oils and control .The raw data taken during experimental trials are shown in Appendix 14. These data are also presented in fig. 4.17. The color values L* of edible oil treated seeds increased ranged between 33.33 to 33.99 and a* color value of treated seeds increased, range between -3.12 to -4.98 was observed, indicating that the greenness in green gram seeds of treated seeds decreased. As dose level increases, a* color value also increases respectively (in negative), hence deteriorating color of seeds. The maximum increase in a* color value was observed in mustard oil treated seeds @ 9 ml/kg seeds; hence, some deterioration in greenness of mustard treated oil seeds has been reported. The minimum effect on seeds treated with sesame oil @ 3ml/kg seeds was found.

Data were statically analyzed and ANOVA is presented in Table 4.13 and 4.14.These treatment had shown significant effect on a* color value at 5% level of significance (Table 4.13). Whereas these treatments had shown no significant effect for L* color value at different levels of significance. (Table 4.14)

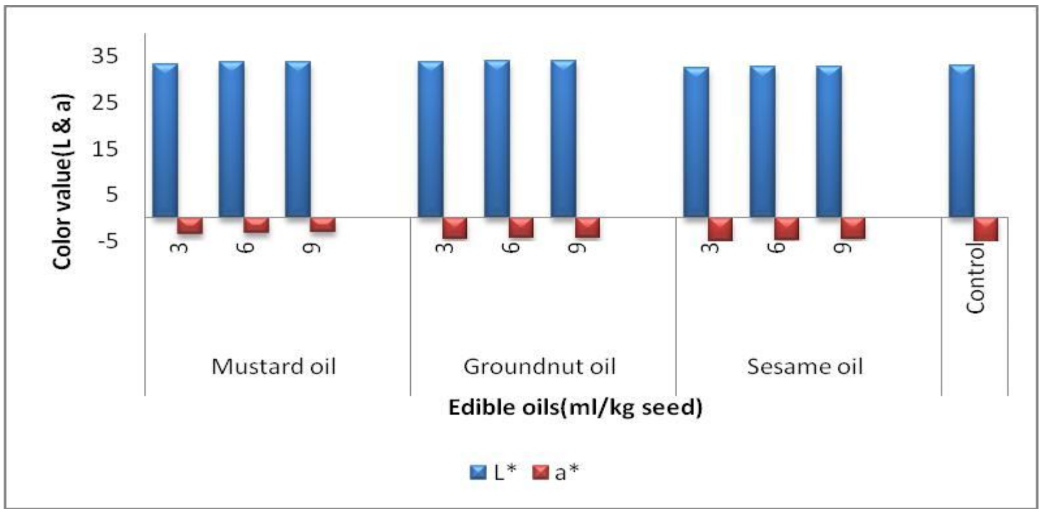

Fig. 4.17 Variation in color value on 120 DAT with different edible oils

Table 4.13: Analysis of variance for L* value in seeds treated with edible oils on 120 DAT

Source of Variation	**D.F.**	**SS**	**MSS**	**F (cal)**
Treatment	9.0000	8.6614	0.9624	0.2364 ^{ns}
Error	20.0000	81.4092	4.0705	
C.V.%				**4.58**

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant.

Table 4.14: Analysis of variance for a color value in seeds treated with edible oils on 120 DAT

Source of Variation	D.F.	SS	MSS	F (cal)
Treatment	9.0000	12.3855	1.3762	38.6612**
Error	20.0000	0.7119	0.0356	
C.V.%				-4.51

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant

4.5.2. Effect of plant products on color value of green gram seeds after 120 days storage

There was no difference found in b* color value of seeds treated with plant product and control. The raw data taken during experimental trials are shown in Appendix 15.These data are also presented in fig. 4.18. The color values L* of treated seeds increased, ranged between 33.22 to 33.95 and a color value of treated seeds decreased, range between -5.70 to -6.40 was observed, indicating that the greenness in green gram seeds of treated seeds increased as compared to control (-5.55). As dose level increases, a* color value also decreases respectively (in negative), hence; enhancement in color of green gram seeds recorded. The maximum increase in a* color value was observed in papaya powder treated seeds at 9 g/kg seed. The minimum increment in a* color value was found in seeds treated with lemon leaf powder at 3g/kg seed. Data were statically analyzed and ANOVA is presented in Table 4.15 and 4.16. These treatment had shown significant effect on a* color value at 5% level of significance (Table 4.15). Whereas these treatments had shown no significant effect for L* color value at different levels of significance.(Table 4.16)

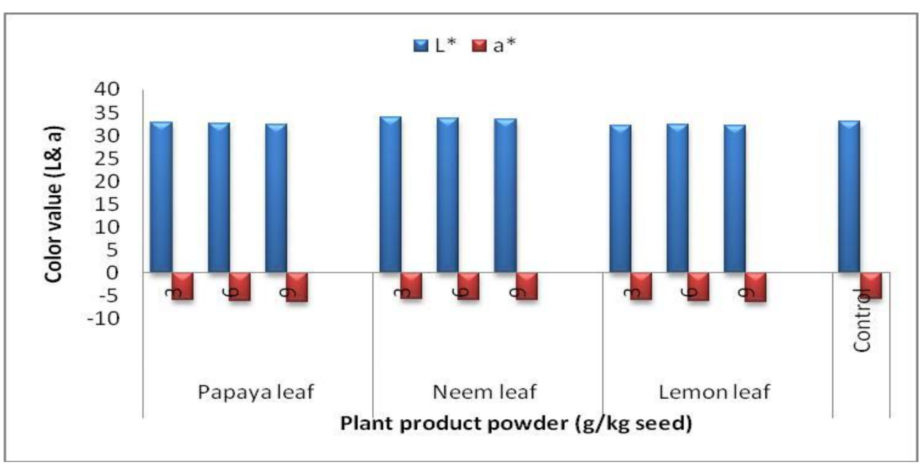

Fig.4.18. Variation in color value on 120 DAT with different plant products

Table 4.15: Analysis of variance for L* value in seeds treated with plant products on 120 DAT

Source of Variation	D.F.	SS	MSS	F (cal)
Treatment	9.0000	12.2267	1.3585	0.6021^{ns}
Error	20.0000	45.1293	2.2565	
C.V.%				**4.57**

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant.

Table 4.16: Analysis of variance for a*value in seeds treated with plant Products on 120 DAT

Source of Variation	D.F.	SS	MSS	F (cal)
Treatment	9.0000	2.0125	0.2236	2.9524*****
Error	20.0000	1.5148	0.0757	
C.V.%				-4.59

NOTE: *significant at 5% level of significance,** significant at 1% level of significance,ns-non significant.

CHAPTER 5

SUMMERY AND CONCLUSIONS

Pulses are the excellent source of protein, rich in important vitamins and minerals. Hence make the diet balanced and nutritive Green gram *(Vigna radiata*) belongs to the family *leguminoseae*. Green gram is highly nutritious containing 24.6% protein, 1.2 % fat, 56.6 % carbohydrate. It is consumed in the form of split pulse as well as whole pulse, which is an essential supplement of cereal based diet. Pulse beetle is a major economically important pest of all pulses and causes 40-50% in storage losses.

Food grain production in India has reached 250 million tonnes in the year 2010-2011, in which nearly 20–25% food grains are damaged by stored grain insect pests. Bio-pesticide is a formulation made from naturally occurring substances that controls pests by non toxic mechanisms and in eco friendly manner; hence gaining importance all over the world. During recent years considerable attention has been paid to: exploitation of plant materials in protection of food commodities from insect infestations.

Many authors have evaluated the insecticidal (grain protectant) properties of plant products on various species of stored product insect pests. The results clearly show that it is possible to develop methods for grain protectants with reduced use of synthetic chemical insecticides. The main advantages of botanical pesticides are eco friendly, easily biodegradable, nontoxic to non target organisms, and many plant-derived natural products acting against insects could be produced from locally available raw materials.

Traditionally, educational and extension efforts have not provided growers with the necessary information to help identify natural enemies. Hence: a study has been proposed to assess and determine the safety and quality of green gram by using different edible oils (mustard oil, groundnut oil and sesame oil) and plant products (papaya leaf, neem leaf and lemon leaf) with different doses, at various time interval for 120 days storage with the following objectives.

- To evaluate the bio-efficacy of edible oils and plant products against pulse beetle.

- To determine the effect of edible oils and plant products on the proximate value of green gram.

- To observe the effect of edible oils and plant products on the color value and germination of green gram.

Effect of different edible oils and plant product at different levels of doses was explored for increasing shelf life of green gram seeds. Hence the storage study was carried out with three edible oils and three plant products, with three doses to select the best combination of dose and material that maintains the quality parameter. The observation for pulse beetle mortality was taken after each 24 hour of application for three days. Germination ability was checked after each 0, 30. 60. 90. 120 days of application. The observations for color and bio chemical analysis were taken after 120 days application of both edible oils and plant product. The experiments were carried out as per the standard procedures as explained in chapter 3. Based on stastical analysis of data, the following interferences have been drawn from the study:

- On the basis of parameters studied (mortality, fecundity ,deterrency ,holes/seeds, weight loss) groundnut and sesame oil treated seeds were found highly effective to resist the insect infestation. All the treatments were found effective in inhibiting the growth of insect and maintaining overall quality. Seeds treated with higher doses were found more effective as compared to lower doses.

- Adult mortality was recorded 100 per cent in groundnut and sesame oil treated seeds @ 6 ml/kg seeds. Both seeds treated with edible oil at 6 ml/kg were more effective than higher doses of other edible oil. There was no significant difference found between the effect of groundnut and sesame oil treated seeds. The seeds treated with mustard oil (3 ml/kg seed) were least effective among all edible oil treatments.

- The minimum no of egg (0.30) per seed was recorded in seeds treated with groundnut and sesame oil (9 ml/kg seed) after 120 days of treatment. No holes were recorded in the seeds treated with groundnut and sesame oil at same rate after 120 days storage.

- Minimum weight loss (1.33%) was observed in seeds treated with sesame and groundnut oil at 9 ml/kg as compared to untreated check (45.50 %).

- Increase in fat content of green gram treated seeds with edible oils on 120 days after storage has observed. Where as protein and carbohydrate content were remained unchanged.

- On the basis of parameters studied (mortality, fecundity ,deterrency ,holes/seeds, weight loss) papaya leaf powder treated seeds were found highly effective in inhibiting the pulse beetle infestation among investigated plant products .

- Mortality was recorded 100 % in seeds treated with papaya leaf powder on three days after treatment. Weight loss was recorded 10.8 per cent in seeds treated with papaya leaf powder at 9 g/kg seed.

- Non significant changes were observed in green gram germination in both the seeds treated with edible oils and plant products up to 120 days after treatment.

- No adverse effects were found in fat, crude protein and carbohydrate content of both seeds treated with different plant products.

- Non significant effect on color value of edible oil treated seeds has been observed. Plant product powder treated seeds have shown up gradation in color value after 120 days of storage. All the treated and control seeds were as viable as the untreated seeds.

- These results suggest groundnut oil and sesame oil (6 ml/kg seeds) among edible oils and papaya leaf powder @ 9 g/kg seed, may be an effective treatment of maintaining green gram quality and extending their post harvest life.

Suggestions for future work

- Effect of edible oils and plant product should be studied on the mineral content of green gram
- Effect of edible oil and plant product should be studied on cooking quality, milling quality and baking quality of green gram.
- Increase the time period of storage and the experiment will be conduct in rainy season.
- Calculate the seed vigor index**.**

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