

Effect of *Trigonella Foenumgraecum* Seeds on the Productive, Reproductive Performance and Some Biochemical Traits in the Local Rabbits

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Abstract: This study was conducted on 15 local rabbits in Animal Farm, College of Veterinary Medicine, University of Baghdad during the period from 2015-2016. Animal's age ranged 8-10 months old equally and randomly divided into three groups (5 does for each) according to the type of treatment. 1st group (C) were considered as the control group (without treatment), 2nd group (G1) which treated by 1.5% *Trigonella Foenumgraecum* seeds (Fenugreek seeds) for 60 days, 3rd group (G3) treated by 3% *Trigonella Foenumgraecum* seeds (Fenugreek seed) for 60 days. All animals in this study exposed to fertile males (3 male aged 1 year) daily after seeds treatment. The result showed that the animal's body weight was recorded higher significant differences ($p < 0.05$) for the G2 and G3 groups (2.16 ± 0.05 and 2.19 ± 0.08) compared with control group (1.95 ± 0.03), PCV percentage and total protein concentration was recorded significant differences ($p < 0.05$) in G2 and G3 group compared with control group. Glucose and triglyceride concentration showed significant reduction ($p < 0.05$) of the treated groups compared with control group. Cholesterol in serum concentration was significantly ($p < 0.05$) decrease in the treated group with Fenugreek seeds (G3) however the treated groups showed significant ($p < 0.05$) increase in blood total protein, albumin and globulin concentration. While the estrogen hormone concentration showed significant increase of the G3 group treated with 3% of the Fenugreek seeds while progesterone concentration showed significant reduction of the G3 group (1.65 ± 0.22) compared with the G2 and control groups (2.0 ± 0.20 and 3.25 ± 0.36 respectively). We concluded that using of Fenugreek seeds with different percentage play an important role for improvement the productivity of the local rabbits by increased the body weight, PCV and offspring percentage as well as the cholesterol, glucose and total protein concentration enhancement.

Keywords: local rabbits, cholesterol, *Trigonella Foenumgraecum* seeds

1. Introduction

It is one of the oldest known cultivated plants through ages, which has found wide application as feed additive and in the traditional medicine in many regions where has been cultivated (Prasana; 2009).

Fenugreek seeds are containing sufficient amount of vit C. and vit E. and used as antioxidant substance (blood free radical's detoxification). it is beneficial in the treatment of indigestion, flatulence, and sluggish liver, as well as, it used for cough treatment and asthma, also it is used as lactation promotes and consider one of the earliest sexual activator agent (Al-Rawi and Chacraravaty; 1988). It is used for meat production and frozen and dairy product as preservative; in addition, it is used for treatment of wounds (Khosla *et al.*; 1995). It also used as a bactericidal activator (Al-Awadi; 1993). Fenugreek seeds, also it is used for hypoglycemic effect (Srinivasan; 2006), and it is used cures dandruff. Also it is used for smoothing skin that irritant by eczema and used as lubricant in the mucous membrane and skin, and it is used to prevent local inflammation and anorexia. Moreover, it used to prevent kidney stone by reducing precipitate calcium oxalate. However it is used for lessen the chance of developing colon cancer by blocking the action of certain enzymes (Sharma *et al.*; 1996).

As well as, Raju *et al.* (2001) showed that fenugreek seeds have an erythropoietin action. On the other hand, feeding of 300, 600, 900 mg / kg B.W fenugreek seeds to male Albino rats for 7-14 days showed a significant increase in WBC counts (Effram *et al.*; 1999).

2. Material and Method

This study carried out at Animal house – College of Veterinary Medicine / Baghdad University, from 10/10/2015 up to 1/1/2016. Fifteen rabbits bought from local market aged 8-10 months with average body weight 1.60-1.80 Kg. Animals fed on a concentrate diet (pellets) and fed on green forage as preliminary period for 2 weeks, they were also supplied freely with tap water. Animals divided randomly and equally into four groups (5 each) according to their body weight as the following:

- 1) First group (C), daily fed 100 mg/ animal (1/2 kg per group of aggregates were obtained) of the concentrate diet (pellets) /animal and kept as a control group .
- 2) Second group (G2) was daily fed on the same amount of the concentrate diet adding 1.5% of body weight *Trigonella Foenumgraecum* seeds for 2 months.
- 3) Third group (G3), also was fed the same level of concentrate diet/ animal adding 3% of body weight *Trigonella Foenumgraecum* seeds for 2 months.

The samples and examination included in the study:-

- 1) Body weights of all animals were taken biweekly interval to determine the changes in body weight.
- 2) Blood samples were taken biweekly to study blood character which included PCV which estimated by using microheamatocrits and results measured by Hawksley microhematocrit ruler reader (John and Lewis, 1984). Cholesterol concentration measured by Allain *et al.*, (1992), Triglycerides concentration measured according to Buccolo and David (1973), Blood glucose level was estimated using Trinder, (1969), Total protein concentration was measured as mentioned by Henry *et*

al., (1974), Albumin concentration was measured according to Doumas et al., (1971), and Globulin concentration determination by Coles, (1986).

As well as recorded the serum level of estrogen and progesterone concentration by using specific kits and gamma counter (Freeman & Blaufox, 1975) in specialist laboratory for hormones analysis, statistical analysis include mean, standard error, F-test and analysis of variance were used and conducted according to (Steel and Tarries, 1980).

3. Results and Discussion

1-Body weight

The results showed that the body weight of the treated group G2 and G3 were significantly ($p < 0.05$) increased compared with the control group. May be related to the feeding system, or may due to the seeds in the ration which improved the palatability and increased feed intake or to the high nutrient content of carbohydrate, protein minerals and vitamin in the seeds (Tipu; et al.; 2006).

Table 1: Effect of *Trigonella Foenumgraecum* body weight (Kg) of local male rabbits. (Means \pm SE).

Group Period	Control Mean \pm S.E.	G1 Mean \pm S.E.	G2 Mean \pm S.E.
1	1.67 \pm 0.02 a	1.77 \pm 0.06 a	1.76 \pm 0.09 a
2	1.76 \pm 0.04 a	1.92 \pm 0.06 a	1.91 \pm 0.08 a
3	1.86 \pm 0.02 a	2.06 \pm 0.06 a	2.05 \pm 0.07 a
4	1.95 \pm 0.03 b	2.16 \pm 0.05 a	2.19 \pm 0.08 a

The different lowercase letters in a row refer to significant differences between different groups at ($P < 0.05$).

However, fenugreek seeds are rich in vitamin E and this make it used as antioxidant substance from free radicals (AL-Rawi and Charcravarty; 1988). Also these herbal medicines contain high ratios of protein and inhibit stress factors due to oxidation as flavonoides, like apigenin and volatile fatty acids which caused as an appetizer and as digestive activators (AL- Shahat; 1986 and Cabuk et al.; 2003).

2- PCV

Table (2) showed that treated group(G3) with 3% *Trigonella Foenumgraecum* were significantly ($p < 0.05$) increased than other groups along the treated period that could be attributed to that those rabbit were in good mangemental and feeding regime. By progress of time and age there was significant ($P < 0.05$) increase in the treated groups compared with the control group. This result may be to increase in feed intake because of an increase in appetite results in increase absorption of nutrients in the intestine that reflect more metabolic activation in the animals, beside these feed additives contain high ratio of crude protein and Iron (Minorova et al.; 1991 and AL-Shahat; 1986). The seeds also contain high ratios of vitamin C and vitamin E which play a vital role on Hb synthesis and has a vital role in oxidation, also these feed additives contain high ratio of flavonoides which play as antioxidant proprieties against free radicals (Okitaet al. ; 2000).

Table 2: Effect of *Trigonella Foenumgraecum* PCV percentage (%) of local male rabbits. (Means \pm SE)

Group Period	C Mean \pm S.E.	G1 Mean \pm S.E.	G2 Mean \pm S.E.
1	28.50 \pm 1.71 b	32.50 \pm 0.50 ab	34.50 \pm 1.70 a
2	30.00 \pm 0.81 b	34.00 \pm 0.82 a	36.50 \pm 1.26 a
3	30.25 \pm 0.85 c	35.75 \pm 1.03 b	41.00 \pm 1.29 a
4	33.50 \pm 0.95 b	39.50 \pm 0.96 a	40.50 \pm 0.95 a

The different lowercase letters in a row refer to significant differences between different groups at ($P < 0.05$).

3-Blood glucosein serum concentration

Blood glucose of all rabbits groups decreased with time progress along the studied period (Table, 3) but the treated groups G2 with 3% *Trigonella Foenumgraecum* showed significantly ($P < 0.05$) lower values than the control group at the third period of the experiment up to the end.

Table 3: Effect of *Trigonella Foenumgraecum* glucose (g /dl) of local male rabbits. (Means \pm SE).

Group Period	C Mean \pm S.E.	G1 Mean \pm S.E.	G2 Mean \pm S.E.
1	103.00 \pm 0.41 a	101.25 \pm 1.49a	103.50 \pm 1.44a
2	102.50 \pm 1.44 b	105.00 \pm 1.22a	107.50 \pm 1.75ab
3	106.50 \pm 1.44 a	86 0100.50 \pm a	0.87 97.50 \pm b
4	105.25 \pm 1.97 a	97.00 \pm 2.12a	0.71 94.00 \pm b

The different lowercase letters in a row refer to significant differences between different groups at ($P < 0.05$).

The reduction in blood sugar levels of rabbits fed fenugreek seeds used as feed additives compared with control group could be attribute to that fenugreek seeds can activate the insulin function that can be used as antidiabetic, which is agreed with those found by Khalki et al. (2010). Who concluded that fenugreek seeds have a vital role for reducing blood sugar level in rats those induced by streptozotocin. This result agreed with the findings of Khosla et al. (1995).

1- Cholesterolin serum concentration

Cholesterol concentration of all rabbits groups decreased with time progress along the studied period (Table, 4) but the treated groups with 3% *Trigonella Foenumgraecum* showed significantly ($P < 0.05$) lower values than the control group at the 4 period of the experimental, their values were 87.82 \pm 4.01, 69.08 \pm 3.18 and 57.02 \pm 2.43for the control, G2, G3 groups respectively.

Table 4: Effect of *Trigonella Foenumgraecum* cholesterol concentration(g / dl) of local male rabbits. (Means \pm SE).

Group Period	C Mean \pm S.E.	G1 Mean \pm S.E.	G2 Mean \pm S.E.
1	81.49 \pm 5.93a	73.95 \pm 8.44315a	69.88 \pm 8.39 a
2	84.01 \pm 6.68a	76.23 \pm 4.80ab	64.20 \pm 1.56 b
3	88.97 \pm 6.03a	68.41 \pm 4.23b	60.06 \pm 4.30 b
4	87.82 \pm 4.01a	69.08 \pm 3.18b	57.02 \pm 2.43 c

The different lowercase letters in a row refer to significant differences between different groups at ($P < 0.05$).

Crowell (1999) showed that Fenugreek oil caused a reduction in cholesterol level as a result of inhibition the main enzyme which create the cholesterol in the liver, also

Valette *et al.* (1984) showed that seeds improved the bile acids and causing a complex compounds with cholesterol in the gut then inhibit it absorption.

2- Triglycerol in serum concentration

The result showed significant decrease ($P < 0.05$) of the G2 and G3 groups compared with the control group along all the period of the study.

Table 5: Effect of *Trigonella Foenumgraecum* triglycerol concentration of local male rabbits. (Means \pm SE).

Group Period	C Mean \pm S.E.	G1 Mean \pm S.E.	G2 Mean \pm S.E.
1	114.64 \pm 3.75 a	99.21 \pm 3.77 b	94.19 \pm 2.94 b
2	114.87 \pm 3.50 a	90.04 \pm 2.79 b	91.33 \pm 2.23 b
3	106.10 \pm 3.31 a	80.92 \pm 1.42 b	91.01 \pm 2.56 b
4	102.71 \pm 3.43a	87.37 \pm 2.31 b	76.33 \pm 2.99 c

The different lowercase letters in a row refer to significant differences between different groups at ($P < 0.05$).

The reduction in the triglyceride concentration of the treated groups G2 and G3 may related to the beneficial physiological attributes of fenugreek seeds have been see in animal studies as well as human trials. These include antidiabetic effect, hypocholesterolemia influence, antioxidant potency, digestive stimulant action, and hepatoprotective effect. Among these beneficial physiological effects, the antidiabetic and hypocholesterolemia property of fenugreek, both of which are mainly attributable to the intrinsic dietary fiber constituent, have promising nutraceutical value. (Jain *et al.*, 1987 and Srinivasan; 2012).

3- Total protein, albumin and globulin in serum concentration

Total protein was increased with age progress up to the end of the experimental period (Table, 6), but the treated groups (G2, G3) showed significantly ($P < 0.05$) higher values than the control group at the 4th period of the experimental. Similar trends were obtained for albumin and globulin content (Table, 7 and 8). i.e. the treated groups recorded significantly ($P < 0.05$) higher values than those of the control group, however fenugreek group showed higher values than control group either significantly ($P < 0.05$) during late period of the study.

Table 6: Effect of *Trigonella Foenumgraecum* protein concentration of local male rabbits

Group Period	C Mean \pm S.E.	G1 Mean \pm S.E.	G2 Mean \pm S.E.
1	6.43 \pm 0.52 a	7.09 \pm 0.45 a	6.64 \pm 0.54 a
2	6.32 \pm 0.42 a	6.35 \pm 0.25 a	6.90 \pm 0.21 a
3	5.91 \pm 0.59 b	7.15 \pm 0.41 ab	7.55 \pm 0.24 a
4	6.56 \pm 0.11 b	7.19 \pm 0.17 a	7.53 \pm 0.23 a

Table 7: Effect of *Trigonella Foenumgraecum* albumin concentration of local male rabbits. (Means \pm SE)

Group Period	C Mean \pm S.E.	G1 Mean \pm S.E.	G2 Mean \pm S.E.
1	3.31 \pm 0.15a	3.36 \pm 0.34a	3.06 \pm 0.48 a
2	3.57 \pm 0.25b	2.96 \pm 0.12 a	3.51 \pm 0.07ab
3	3.13 \pm 0.31a	3.38 \pm 0.25 a	4.01 \pm 0.24 a
4	3.17 \pm 0.045a	3.42 \pm 0.08 a	3.54 \pm 0.22 a

Table 8: Effect of *Trigonella Foenumgraecum* globulin concentration of local male rabbits. (Means \pm SE)

Group Period	C Mean \pm S.E.	G1 Mean \pm S.E.	G2 Mean \pm S.E.
1	3.11 \pm 0.38a	3.73 \pm 0.31a	3.57 \pm 0.14a
2	2.75 \pm 0.20c	3.3800 \pm 0.15b	4.00 \pm 0.17a
3	2.785 \pm 0.27b	3.51 \pm 0.12a	3.78 \pm 0.51a
4	3.39 \pm 0.06c	3.77 \pm 0.08b	3.98 \pm 0.00a

The increase in the total protein and its components in all groups could be due to an increase in the metabolic rate, and may be those rabbits were under growth, these result agreed with Baungarther and Pernthner (1994). However with time and age progress all treated groups showed significantly ($P < 0.05$) higher values compared with the control group at 3rd period of feeding regime up to the end. This could be due to that those feed additives contain high ratio of protein (AL-Shahat; 1986). Also fenugreek seeds could be used as a digestive stimulant causing an increase in appetite (Weiss; 2002 and AL- Rawi and Chacravarty; 1988), and have a strong antioxidant activity which contain flavonoides (Bngel and Famswarth; 1991). The increase in the globulin in the blood as was noticed in this study could be due to that feed additives contain vitamin E which plays a positive effect on humeral immunity (Awadla *et al.*; 1980).

7-Estrogen and progesteronein serum concentration

Table (9) showed that the concentration of estrogen hormone were significantly ($P < 0.05$) higher in the treated group with 3% *Trigonella Foenumgraecum* G2 group than G1 and control groups.

While the progesterone concentration table (10) showed significant reduction ($P < 0.05$) in the hormone concentration of the G2 group compared with control and G1 groups.

The off spring percentage were increased significantly ($P < 0.05$) in the treated groups G1 and G2 compared with control group.

Table 9: Effect of *Trigonella Foenumgraecum* estrogen concentration of local male rabbits. (Means \pm SE)

Group Period	C Mean \pm S.E.	G1 Mean \pm S.E.	G2 Mean \pm S.E.
1	88.45 \pm 1.60c	162.70 \pm 1.41b	171.35 \pm 1.94a

Table 10: Effect of *Trigonella Foenumgraecum* progesterone concentration of local male rabbits. (Means \pm SE)

Group Period	C Mean \pm S.E.	G1 Mean \pm S.E.	G2 Mean \pm S.E.
1	3.25 \pm 0.36a	2.00 \pm 0.20a	1.65 \pm 0.22b

Table 11: Effect of *Trigonella Foenumgraecum* offspring of local male rabbits. (Means \pm SE)

Group Period	C Mean \pm S.E.	G1 Mean \pm S.E.	G2 Mean \pm S.E.
1	3.50 \pm 0.50b	5.25 \pm 0.25a	5.00 \pm 0.50a

This may be due to the effect of the nutrients content of *Trigonella Foenumgraecum* seeds, which affect as antioxidant defensive system and during its direct effect on the ovary. However, specific extract of fenugreek seeds

which was shown a double-blind study of healthy animal to significant increase both libido and the ability of orgasms (John and Biggs; 2009). Hence reduced level of circulating estrogen contributes to altered physiology of female reproductive system Fenugreek (*Trigonellafoenum-graecum*) is considered to be a rich source of steroidal sapogenins (Hardman, 1969). Thus, the present investigation suggests that steroidal fraction of fenugreek seeds extract exerts antifertility and antiestrogenic activity in female rats.

The improvement in the treated group could be due to its content of Vit. E and flavonoids which have antioxidant activity that stimulated antioxidant system, which similarly to some extract to the chemical structure of sex hormone earned some bioflavonoids and androgenic effect (Hertog *et al.*; 1993). However, fenugreek seeds also contain Vit. E and flavonoids and testofen which standerized its self to 50% fenuside, one of the photochemical in fenugreek seeds is claimed to be relatively neutral cholesterol hormone (Grover, *et al.*; 2002).

References

- [1] Al-Awadi; S. G.(1993). Study on the antibacterial effect and mutation capacity of some medical herbals. M.Sc. Thesis; College of Veterinary Medicine; University of Baghdad.
- [2] Allain; C.C., Poon; L.S., Clau, C.S.G., Richmond; W. and Fu; P.D. (1992).Clinical Biochem.; 29:577.
- [3] Al-Rawi; A. A. and Charcravarty; H. L. (1988). Medical Plants of Iraq . Ministry of Agiculture and Agrarian Reform. Baghdad, Iraq .Al- Ukatha Champion; 73-110.
- [4] Al-Shahat; N. A. (1986). Medical Herbal and Herbal 1st (ed)., Dar Al- Kuttib Company Beirut, Lebanon.
- [5] Awadla; M.Z.; El-Gendaily; A.M. and El-Shamy; A. (1980). Studies on some Egyptian food. Part 2. The effect of protein blood constituent of rats.J.Food Sci., 19(4). 248-250.
- [6] Baungarther ;W. and Pernthner ; A. (1994) Influence of age, season and pregnancy on blood parameters in A strain Karakul sheep, Small Rumen. Res ., 13 : 147-151.
- [7] Bngel; A. S. and Famswarth; N.R.(1991). Higher Plant as Potential Source of Galactogogues. Academic Press Ltd; New York. ; Vol (1):45-54.
- [8] Buccolo, G. and David, H. (1973). Clin. Chem. 19:476.
- [9] Cabuk; M., Alcicek; A., Bozkurt; M. and Imer; N. (2003). Antimicrobial properties of the essential oils isolated from aromatic plants and using possibility as alternative feed additives. II. National Animal Nutrition Congress. 18-20 September, Konya, Turkey, pp: 184-187.
- [10] Coles; E.N. (1986). Veterinary Clinical Pathology 4th (ed.) W.B. Saunders Co. Philadelphia, USA.
- [11] Crowell; P.L. (1999). Prevention and therapy of cancer by dietary monoterpenes. J. Nutr., 129: 775-778.
- [12] Doumas; B.T., Wastom; W.A. and Bigges; H.G. (1971). Clinical Chemistry Acta.; 31:87.
- [13] Effram ; K . D ., Salami ; A . and Newfor; P . A.(1999). Effect of aqueous seeds extraction of *Trigonellafoenum* on hematological parameters in Albino rats . African J. Bio . Med. Res. ; 2; 47-51.
- [14] Freeman, L.M. and Blaufox M.D. (1975) . Radioimmunoassy .Dept. of radiology, Albert Einstein college of medicine, Yeshiva University, Brony, New York .
- [15] Grover; J.K., Yadav; S. and Vats; V.(2002). Medicinal plants of India with antidiabetic potential. J. Ethnopharmacol.;81:81– 100.
- [16] Hardman. R. 1969. Pharmaceutical products from plant steroids. Trop. Sci. 11:196-222.
- [17] Henry; R.J.; Cannon; D.C. and Winkelman; J.W. (1974). Clinical Chemistry Principles and Techniques; 2nd (ed). Harper and Row.
- [18] Hertog; M.G.L., Feskens, E.J.M., Hollman; P.C.H., Katan; M.B. and Kromhout; D.(1993). Daitary antioxidant flavonoids and risk of coronary heart disease. The Zupthen Elderly study. Lancet; 342:1007-1011.
- [19] Jain S.C., Kapoor A. and Lohiya N.K. (1987) : Triogonellafoenum–graecum Linn.- A Hypoglycaemic agent. Indian J. Pharm. Sci. 49(3), 113-114
- [20] John; H. and Biggs; N.C.P. (2009). How to boost testosterone naturally? J. International Society of Sports Nutrition, 60 (S1): 12.
- [21] John; S.V. and Lewis; S.M. (1984). Basic Hematological techniques Practical Hematology, 6th (ed): 22-45.
- [22] Khalki; L., M'hamed; S.B., Bennis; M., Chait; A. and Sokar; Z. (2010) Evaluation of the developmental toxicity of the aqueous extract from *Trigonellafoenum-graecum* (L.)in mice. J. Ethnopharmacol.; 15 321–325.
- [23] Khosla;P., Gupta; D.D. and Nagpal; R.K. (1995). Effect of *Trigonellafoenumgraecum* L on blood glucose in normal and diabetic rats. Indian J PhysiolPharmacol; 39(2): 173-174.
- [24] Minorova, A. N.; Filippova, G.I.; Fedina, N.I.; Volkova, Z.D.; Kozlova, V. L.; Alymova, T. B.; Gorshkova, E. I.; Bykova, S. F. (1991), Chemical and biological properties of coriander fatty oil. VoprPitan., 1, 59-62.
- [25] Okita ; M., Sassagawa ; T .and Katani ; M. (2000) Green vegetable juice increase poly-unsaturated fatty acid of erythrocyte membrane, phospholipids in hypercholestremic patient . Asia – Pacific J. Clin . Nutr . ; 4:309-320.
- [26] Prasana; M . (2009) Hypolipidimic effect of fenugreek : Clinical study . Indian JornalPharmacol .; 2(5);114-117.
- [27] Raju; J., Gupta; D., Rao; AR., Yadava; P.K. and Baquer; N.Z (2001) TSP foenumgraecum (fenugreek) seed powder improves glucose homeostasis in alloxan diabetic rat tissues by reversing the altered glycolytic, gluconeogenic and lipogenic enzymes. Mol. Cell. Biochem.; 224 45–51.
- [28] Sharma; R. D., Sarker ; A.andHazra; D. K. (1996). Hypolipidimic effect of fenugreek seeds . A chronic study in immune- deficient disease's patient, Phytotherapy, Res . ; 10(4) :332-4334.
- [29] Srinivasan; K. (2006) Fenugreek (*Trigonellafoenum-graecum*): A review of health beneficial physiological effects. Food Rev. Int.; 22 203–224.

- [31] Srinivasan; K. (2012). Antioxidant Potential of Spices and Their Active Constituents. Critical Reviews In Food Science And Nutrition. Pages 203-224.
- [32] Steel, R. G. and Tarries, J. H. (1980). Principle and procedure of statistical 2th ed., Mc grow Hill book. Co. In. New York.
- [33] Tipu; M. A., Akhtar; M. S., Anjumi; M. I. AND Raja; M. L. (2006). New dimension of medicinal plants as animal feed. Pakistan, Vet. J. 26(3): 144-148.
- [34] Trinder; P. (1969). Clinical Biochemistry. Ann. 6:24.
- [35] Valette, G., Sauvaire, Y., Baccou, J. C. & Ribes, C. (1984). Hypocholesterolemic effect of fenugreek seeds in dogs. Atherosclerosis 50, 105-111
- [36] Weiss; E.A. (2002). Spice Crops. CAB International, Wallingford, UK, p. 41.