Journal of New Sciences
Volume 11(1). Published November, 01, 2014
http://www.jnsciences.org

Research open acess

The effect of organic composts on the chemical characteristics of fenugreek (*trigonellafoenum greacum*) from sudan and tunisia

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Abstract - Proximate composition and quality of seeds for Fenugreek plant from Sudan and Tunisia were examined in their response to two types of organic composts compared to control. Organic composts are prepared from animal manures and wheat husks by different combinations. The addition of organic composts is significantly affecting the quality of fenugreek seeds at 0.05 probability level. It increases (MC, Ash, fat, fiber, carbohydrate and volatile oil), and decreases the protein content significantly at the second season. This result is logically matching the previous reviewed data at this stage; still having a good quality remains the main point to take the accurate decision regarding the organic fertilizer to be added or not; this needs further studies to confirm the result after the three years of transitional period.

Keywords: Medicinal plants, organic production, cultivar, essential oil, seed quality, proximate composition

1. Introduction:

In the recent times, agricultural scenario is witnessing a trend towards organic farming system. It is frequently understood as a system of food production and consumption proper to environmentally- and health-conscious people of the developed world. It is seen that agricultural products produced through organic farming, without using any chemical fertilizers and pesticides, fetch high demand and price in the international market. Conversion to organic agricultural systems is aiming at export promotion, economic self-reliance, finding alternatives to decreased access to agricultural inputs, natural resource conservation, food self-sufficiency, and rural and wider social development. (Costanza et al., 1992; Postel, 1994). The main drive of many developing countries to produce organic food and fibers is to tap market opportunities in developed nations. Many secondary metabolites of plant are commercially important and find use in a number of pharmaceutical compounds. Cultural practices and production strategies followed by different farmers differs largely in their returns to the environment as well as the revenue for the local producers. Medicinal plants play important role in human lives in both Sudan and Tunisia, and the whole developing countries. Some plants with pharmaceutical important worldwide properties are considered as daily edible foods in the consumer table in these countries. Still, they dealt with as neglected and low attention is rewarded to them. Fenugreek (*T. foenum-greacum*), is cultivated as a leafy vegetable, condiment and as medicinal plant. Seeds are used for fever, vomiting, anorexia, cough, bronchitis and colonists. An infusion of the seeds is a good cool drink for small pox patients. Powdered seeds find application in veterinary medicine. An aqueous extract of the seeds possesses antibacterial property (Kumar et al, 1997; Warrier et al, 1995).

Two organic composts are developed from different combinations of animal manures and wheat husks. They are applied for two cultivars of fenugreek from Sudan and Tunisia (Fen_{SDU} and Fen_{TUN}) as referred to in this study. The experiment was implemented in two successive seasons (2007-2008 and 2008-2009), by using the split plot design at INAT experimental farm (10_o11, Latitude: 36_o 55, and Altitude 10 m)- Tunisia.

2. Material and methods

2.1. Preparation of organic composts:

Two types of composts were developed by different combinations of animal manure (cows, goats, and chicken manures) mixed with Wheat husks (50%, 20%, 20%, 10% and 30%, 30%, 30%, 10%) of each feedstock material respectively for compost1 and compost2 (CMPST1 and CMPST2). The aerated pile method used according to (CTAB, 2005). The composted materials were then chemically analyzed, (Table 1), and applied to the soil as 24 ton/ha. Soil is pre-irrigated and left for one month before sowing.

2.2. Farm experiment:

The experiment was implemented in two successive seasons (2007-2008 and 2008-2009), by using the split plot design at INAT experimental farm (Longitude: 10^o11, Latitude: 36^o 55, and Altitude 10 m) - Tunisia.

2.3. Chemical analysis:

Seeds were carefully cleaned then ground to pass through a 0.4mm screen, for proximate analysis, on a dry weight basis. AOAC (1990) methods were followed in the determination of moisture, crude fiber, ash and protein Carbohydrate was calculated by difference between soluble sugar and non soluble sugar, and VO% determined according to

2.3.1. Moisture content (MC %):

MC was measured by the loss in weight, after oven drying at 150 ^oC.

2.3.2. Protein content:

Determined by micro-kjeldahl method where the total nitrogen (N) calculated and multiplied by a fixed factor as:

% Protein= N%× 6.25

2.3.3. Ash content (%):

Determined in the defatted plant sample burnt at 500 C_o in a muffle furnace for 2 hours, then the loss in weight calculated.

2.3.4. Fat (%):

The fixed oil in plant tissues is determined by extraction in petroleum ether for eight hours in a soxhelt apparatus.

2.3.5. Crude fiber (%):

Determined in the defatted sample and the organic residue extracted by adding 0.23 N

KOH and 0.26 N (H_2SO_4), boiled, washed, filtered and oven dried at 100 C_o. The ash content is determined by burning at 550 C_o for 2 hours and calculated as:

%Crude Fiber = (Organic residue- Ash Wt×100) / (Wt of organic residue)

2.3.6. Volatile oil:

Extracted by hydro-distillation in 100 g/L base according to the European Pharmacopoeia method (Council of Europe, 1997).

2.4. Statistical analysis:

The acquired data was statistically managed and analyzed by the MSTATC version 2.6, software program (MSTAT-C, 1998). Analysis Of Variance (ANOVA) is computed and the means are separated by Duncan Multiple Test. Means are tested at 0.01 and 0.05 levels of significance. Results are expressed by mean values ±Standard Error of Means (SEM).

3. Results and discussion:

3.1. Moisture content:

MC is noticeably fluctuated between the seasons and among the cultivars with different applied treatments, this could probably be attributed to the environmental conditions, and variations in cultivars themselves. As appear in table (1), the seed of Tunisian fenugreek contains a percentage of moisture higher than the Sudanese fenugreek, unless when it was treated with CMPST1. The results were in accordance in the two seasons. CMPST1 is giving the highest accumulative MC value in the 1st season; it drawback in season two where CMPST2 is giving the highest value of moisture content followed by control and CMPST1 (5.92%, 5.75% and 5.18%) respectively. This result is unlike what mentioned by Abdelgani et al (1999), that no treatment (either fertilizer or inoculation) was found to affect moisture content of Fenugreek seeds significantly, it is affected by the relative humidity of the surrounding atmosphere at the time of harvest and during storage. Many authors reported the moisture content of fenugreek seeds varying from 4.3% (Nour and Magboul, 1986), to 6.2- 6.9% as for Abdelgani et al, (1999) and 10.56% according to Abdel- Nabey and Damir, (1990) and Sowmya and Rajiyalakshmi (1999). The latter is also reported a moisture content as 7.49%. However, it is very difficult in this case to judge that the achieved content of moisture is due to application of certain compost, unless we took the result as part of the other study components, and compare the effect of these applications on the other characteristics under study.

3.2. Ash %:

The accumulative effect of the composts was significantly represented by CMPST2 in the two seasons and both cultivars. The response for composting in the first season is generally expressed by values greater than those of the second season but still the minimum value obtained in this study is greater than the values reported by Sowmya and Rajiyalakshmi (1999) when stated a 3.38%; and a range between 3.34- 3.42% mentioned by Brummera, et al., (2003), 3.9% is reported by Udayasekhara, et al. (1996). This might indicate either the effect of the organic fertilizer or the effect of the varieties themselves. However, CMPST1 has no significant effect in both seasons and both cultivars compared with the control (Table 1).

3.3. Fat%:

Significant fat increase in the 1st season was observed as a response for composting, but a noticeable decrease occurs in season two and no significant differences were detected between the treatments. The addition of CMPST2 is giving the highest accumulative value of fat in the two seasons followed by CMPST1 and control (Fig. 1). Generally, Fenugreek seeds are known to have law crude oil content (El-Shimi et al, 1984; Hemavathy and Prabhaker, 1989). It ranges between 6% as reported by Armosh&Amry, (1999), El-Ghazali et al, (1998); and 6.2 to 7.5%, as stated by Abdelgani et al, (1999). However, Nasir and Tinay, (2007); Montegomery (2009), reported a value reached 7.9% which is still less than most of the values achieved in this study. The highest value obtained of fat content is attributed to F_{TUN} when combined with CMPST2 (10%). However, no significant effect is detected in the two seasons for F_{SUD}; this can be justified by the differences in cultivars and its response to fertilizers as reported by (Joy, et al., 1998); and Saeed and Elsheikh, (1995); that the plant might respond to fertilization highly significantly or not; depending upon the fertilizer, cultivar and soil type.

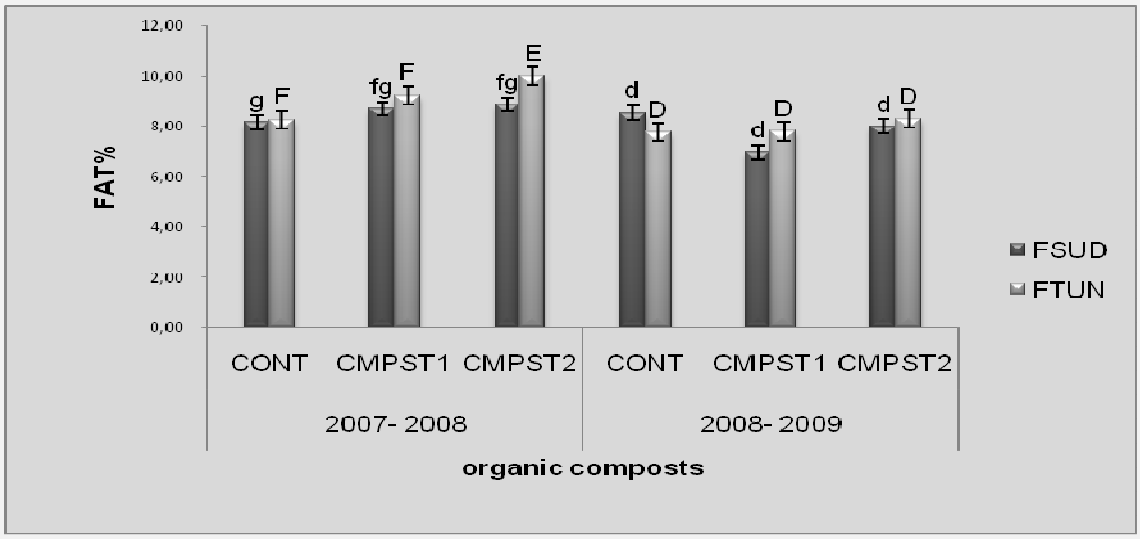

Figure 1: The effect of two types of organic composts on the FAT% for Fenugreek (*Trigonella foenum-greacum L.*) from Sudan and Tunisia for two successive seasons 2007-2008 and 2008- 2009. CONT: control CMPST1: compost type one, CMPST2: compost type two F_{SUD}: Sudanese Fenugreek. F_{TUN}: Tunisian Fenugreek. The values of the same letters are not significantly different at 0.0 5 probability level.

3.4. Fiber%:

The fiber content is significantly increased byCMPST2 in the 1st season and decreased noticeably as affected by CMPST1 in the second season. The higher value of fiber content is achieved in the first season by Tunisian fenugreek combined with CMPST2 (9.21%) compared with only (7.67%) for the Sudanese cultivar as appear in table (1). Fenugreek seeds were reported to have high content of fiber as mentioned by Sharma et al.; (1990). It reached (50g/100g) according to Montegomery, (2009), 65% of dietary fiber as for Meghwal and Goswami (2012) and ranges between 6.5-8.6% as reported by Abdelgani et al, (1999), and Nour & Magboul, (1986) who reported 6.7% of fiber content in Fenugreek seed. The decrease occurred in the 2nd season is expected, but still the gained values considered high when compared with the previous studies.

3.5. Protein %:

The protein content is significantly decreased in response to composting in the 1st season, while an increase in the content in the 2nd season for the F_{SUD} as response to CMPST2, but still no significant difference observed compared with the control.CMPST1increased the protein content F_{TUN} in the 1st season followed by CMPST2 and control (27.77, 25.88 and 24.67) respectively, table (1).This result differs from what reported by Abdelgani et al (1999), as the protein increased to reach (32.6 to 35.8%) as a response to inoculation and Nitrogen fertilizers. Although the protein content of F_{SUD} increased in the 2nd season as response to CMPST2; still no significant difference from control is detected. Generally, the seeds are varying greatly in protein content (22%), according to (El- Ghazali et al, 1998); 25.4 to 27.3% reported by Rao and Sharma, (1987); Abdel-Nabey and Damir, (1990); Meghawal et al, (2012) and Jani R, et al (2009). Moreover, Isikli et al. (2005) reported a proportion of protein ranging from 20 to 30%. But the observed variation could either be attributed to the cultivar variation and/or soil type. As it was mentioned by Sadeghzade et al., 2009; all leguminous crops are affected greatly by environmental stress, soil type and salinity. Moreover; fenugreek property in N fixation and the ability of nitrogen exchange in the cycle can contribute to the fluctuation of the available nitrogen in plant to perform proteins as it dependent on the amount fixed by the plant plus the amount released upon the decomposition of the manures according to the different a-biotic factors controlling it.

3.6. Carbohydrate:

Appear in Fig.2; the significant increase of carbohydrates in fenugreek seeds in both cultivars in the two successive seasons. But is not matching what reported by Abdelgani et al, (1999); he stated that carbohydrates percentages in fenugreek seeds decreased significantly in response to chemical fertilizers. In total the percentage was varied between 37.8 to 44.8% and the same range was reported by Meghwal and Goswami (2012). However, the maximum value obtained in this study is less than the range mentioned by the previous authors (34.3%). However, F_{SUD} responded significantly for CMPST1 in the second season and the content increased to reach 34.73%. The general accumulative effect is associated with CMPST1 followed by CMPST2 and control.

The carbohydrate content in a plant is generally affected by the plant yield and the amount of the green part generated and the leaf area active in photosynthesis; however; the mentioned properties were greatly affected by the amount and type of fertilizer and generally fenugreek responded positively to the addition of organic fertilizer as mentioned by Srinivasan, 2006 and Saeed and Elsheikh, 1995; it is accordingly contribute positively to increase the amount of carbohydrates generated by the leaves and stored on seeds.

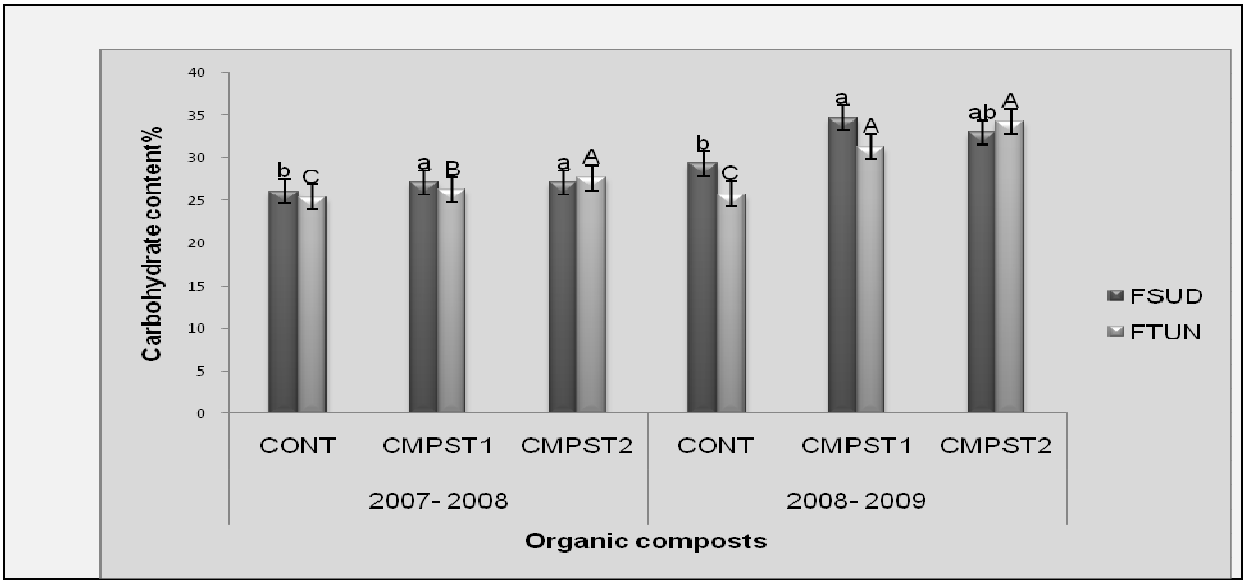

Figure 2: The effect of two types of organic composts on the CARBOHYDRATE (%) for Fenugreek (Trigonellafoenum-greacum L.) from Sudan and Tunisia for two successive seasons 2007-2008 and 2008- 2009. CONT: control CMPST1: compost type one, CMPST2: compost type two FSUD: Sudanese Fenugreek. FTUN: Tunisian Fenugreek. The values of the same letters are not significantly different at 0.0 5 probability level.

Table 1: The effect of organic compost on some chemical characteristics of fenugreek seeds from sudan and tunisia for seasons (2007-2008 & 2008-2009)

Treatments	MC%			Ash%			Fiber%			Protein%			VO%		
	F_{SUD}	F_{TUN}	Mean	F_{SUD}	F_{TUN}	Mean	F_{SUD}	F_{TUN}	Mean	F_{SUD}	F_{TUN}	Mean	F_{SUD}	F_{TUN}	Mean
2007-2008															
CNTRL	7.13±(0.3)^{c}	8.27±(0.3)^{a}	7.70	3.33±(0.2)^{d}	3.36±(0.2)^{d}	3.35	7.10±(0.2)^{g}	6.30±(0.2)^{h}	6.69	32.57±(0.4)^{a}	24.67±(0.4)^{d}	28.62	0.83±(0.02)^{e}	0.84±(0.02)^{de}	0.832
CMPST1	8.33±(0.3)^{a}	7.23±(0.3)^{b}	7.78	3.17±(0.2)^{d}	3.47±(0.2)^{d}	3.32	8.08±(0.2)^{e}	8.47±(0.2)^{e}	8.28	21.11±(0.4)^{e}	27.77±(0.4)^{b}	24.44	0.87±(0.02)^{de}	0.91±(0.02)^{c}	0.892
CMPST2	6.47±(0.3)^{d}	6.97±(0.3)^{d}	6.72	4.13±(0.2)^{c}	3.53±(0.2)^{c}	3.83	7.67±(0.2)^{f}	9.21±(0.2)^{d}	8.45	28.73±(0.4)^{b}	25.88±(0.4)^{c}	27.31	0.82±(0.02)^{e}	0.89±(0.02)^{c}	0.853
MEAN	7.31	7.49		3.54	3.46		7.62	7.99		27.47	26.11		0.837	0.88	
2008- 2009															
CNTRL	5.33±(0.4)^{c}	6.17±(0.4)^{d}	5.75	2.97±(0.2)^{e}	2.73±(0.2)^{e}	2.85	06.80±(0.4)^{b}	08.02±(0.4)^{b}	7.41	29.17±(0.9)^{a}	26.25±(0.9)^{b}	27.71	0.90±(0.09)^{ab}	0.10±(0.09)^{a}	0.50
CMPST1	6.03±(0.4)^{f}	4.33±(0.4)^{c}	5.18	3.93±(0.2)^{e}	2.50±(0.2)^{e}	3.22	06.24±(0.4)^{c}	06.56±(0.4)^{c}	6.40	27.94±(0.9)^{ab}	25.93±(0.9)^{b}	26.93	1.09±(0.09)^{ab}	1.17±(0.09)^{a}	0.63
CMPST2	5.00±(0.4)^{b}	6.83±(0.4)^{e}	5.92	3.80±(0.2)^{c}	4.13±(0.2)^{d}	3.97	06.67±(0.4)^{b}	07.92±(0.4)^{b}	7.30	29.46±(0.9)^{a}	26.26±(0.9)^{b}	27.68	1.17±(0.09)^{a}	1.17±(0.09)^{a}	1.17
MEAN	5.455	5.778		3.567	3.122		6.570	7.499		28.857	26.147		1.054	1.110	

Values are expressed by Means±SEM. Means of the same letters are not significantly different at 0.05 probability level

ISSN 2286-5314

3.7. The volatile oil content (VO%):

VO% has significantly increased by the addition of composts. However, authors mentioned minor percent of volatile oil contained in fenugreek seeds, (Armosh & Amry, 1999, El- Ghazali et al, 1998). It is also observed the variation of the VO content according to cultivars which found to be logical and a plant like fenugreek with its diversified genotypes. In addition to this, the content of essential oil increased in the second season compared with the first unlike what mentioned by (Scialabba, 2000), that, during the transformation period from conventional to organic production; noticeable decreases in yields observed in the second and third year, but the loss is compensated by the premium prices obtained due to good qualities. And this rule could be applied to explain the decreases and drawbacks in the second season in all the characteristics studied. However, some authors reported the same result in some medicinal plants where highest contents of essential oil were measured in the air-dried drug during the first season as reported by Haban, (2007) and Vaverkova et al., (2002).
Generally, the yield of organically produced medicinal plants decreases in the first year of production. This can be attributed to the diminishing available nutrients provided by the fertilizers. In addition to the environmental stress that the plant was facing like insects and diseases. But in the following years of organic production system, the yield increased to reach higher stable amounts. However, plant of a high potentiality to utilize soil humidity and less demanded to soil nutrients can avoid the loss in yield even at the beginning at the organic production system (Haban, 2007, Bernath et al, 1991)

6. Conclusion

It can be concluded that, fenugreek seeds is a rich source of protein, fat, fiber and carbohydrates, and both cultivars from Sudan and Tunisia could be considered as a main dietary in the consumer's table. It can be also concluded that that proximate content of fenugreek seeds is affected noticeably by the addition of the two types of organic compost. However; the combination mixture of manures (Cow manure: Goat manure: Chicken manure) with Wheat husks by (30:30:30:10) percentages of feed stocks respectively; is highly recommended as an organic compost product with a significantly better performance on the chemical characteristics of fenugreek plant. As it is elaborated that the composts differs greatly in their constituents according to the used feedstock, and its origin; the study recommends more critical analysis for the available feedstock for both Sudan and Tunisia in its relation to plant/soil requirements as well as the market demand.

Acknowledgement:

The authors are grateful to Mme. Zainab Gharabi (INAT) for facilitating the essential oil extraction at the laboratory of medicinal plants.

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