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The effect of neutralized and non-neutralized pomegranate pulp on features of *Eisenia fetida* and vermicompost

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ABSTRACT - Vermicomposting with pomegranate pulp can not only prevent pollution of the environment but can also create jobs, generate added value and prevent the waste of energy and the country's capital. This factorial experiment was conducted in a completely randomized design. The first factor (a) in two levels contained neutralized pomegranate pulp with lime and non-neutralized pulp. The second factor (b) vermicomposting mediums which included 9 levels of pomegranate pulp (with levels of 0, 5, 10, 15, 20, 25, 30, 35, and 40 percentage) and cow manure in three replications that formed a total of 54 experimental units. Also, ninety mature earthworms (*Eisenia fetida*) were put into each experimental unit. During the experiment, the daily moisture of mediums was set by weight at 70% of field capacity and the growth chamber temperature at 25±2˚C. The results showed that if pomegranate pulp percentage increases, the population of infant worms (220 worms) and *Eisenia fetida* worms' cocoons (114 numbers) decreases but increasing the population and biomass of adult worms was observed at level of 25 percentage of pomegranate pulp. In addition, the percentage of organic carbon (30.32%) and vermicompost C/N ratio (27.87%) increased by pomegranate pulp enhancement in medium. Also, the highest percentage of nitrogen of vermicompost (1.69%) was found at level of 25 percentage of pomegranate pulp. Furthermore, neutralized pomegranate pulp with lime had improved the measured traits in produced vermicompost and worms compared to non-neutralized pulp in most cases.

INTRODUCTION

Pomegranate, scientifically called *Punica granatum,* belongs to Punicaceae family and is one of the oldest known fruits which is widely cultivated in Mediterranean countries such as Turkey, Egypt, Tunisia, Spain, Morocco and countries like Iran, Afghanistan, India and partially in China, Japan and Russia (Onur et al., 1995). This fruit has vitamins such as B1, B2, B6 and C and also elements like calcium, phosphorus and manganese which balance body fluids, especially blood. 80-85 percentage of the weight of the pomegranate pellets includes its juice or extracts form including glycoside, lipids, organic acid, tannins, and various vitamins and soluble minerals (Mirjalili, 2003). Due to the beneficial properties of pomegranate, people tend to use this fruit, in particular, the use of pomegranate juice and other processed products such as fruit concentrate, fruit paste, etc. has been increasing day by day which, in turn, has led to the increase of related industries which are dependent on the production of this fruit. This factor has caused many pomegranate juice and concentrate factories to produce significant amounts of waste. In addition to environmental problems, these remains cause sad and unpleasant sights in nature (Garcia et al., 2010). The waste produced by these plants, pomegranate peel, contains polyphenols substances like Alajyk acid, Tannins and Gallic acid and Anthocyanin that are used in the manufacturing of paints, cosmetics, and medical formulations (Kaya et al., 1993; Antoun and Tsimidou, 1997; Mohamed & Awatif, 1998; Gu and Weng, 2001; MohdZin and Abdul-Hamid, 2002; Farhoosh, 2003). But, wastes produced in these factories are much more than their need in the mentioned industries. Therefore, producing pomegranate factories proceed to bury and burn or abandon their waste in the nature, which leads to damage to the environment.

Vermi is a Latin equivalent for word 'worm' and vermicomposting also refers to a process in which earthworms are used to produce compost. In vermicompost production process through the decomposition of organic waste materials by certain types of earthworms, a very nutritious, organic, clean and odourless fertilizer with the ability to amend soil is being produced; that, in addition to reducing environmental risks of organic waste, accelerates recycling of them to nature as a fertilizer and can be used as an appropriate alternative to chemical fertilizers in the agricultural and horticultural industries. It should be noted that the vermicomposting process is an environmentally friendly technology that can convert organic and hazardous waste into healthy and environmentally friendly products (Edwards et al., 2010).

So far, vermicomposting has been reported from different organic debris such as leaves, branches and sawdust (Banu et al., 2005), the remains of hay (Mousavi and Raeesi, 2009), sugarcane (Sangwan et al., 2010), corn dough (Musaida et al., 2012) , solid waste (Manyuchi et al., 2013), various agricultural and industrial and kitchen wastes (Ebadi et al., 2006; Singh et al., 2013), garden waste and weeds (Sitre, 2014) and bagasse (Aquino et al., 1994). In all cases listed, for accelerating the process of producing vermicompost and qualified fertilizers, various percentages of manure were also added. Cow manure is one of the best mediums for the growth and activity of *Eisenia fetida* worms (Loh et al., 2005; Siddique et al., 2005; Garg et al., 2006).

Despite studies in the field of producing vermicompost from different organic residues, producing these fertilizers from pomegranate pulp has not been considered. On the other hand, the related industries to these products generate a considerable amount of pomegranate pulp in the country each year. Vermicompost can be produced from remains, which can prevent environmental pollution, create jobs, generate added value and prevent the waste of energy and the country's capital. In this regard, it is of utmost importance to study produced vermicompost characteristics from pomegranate pulp.

MATERIALS AND METHODS

Experimental Design

This experiment was conducted in a completely randomized factorial design with three replications within 80 days. The first factor (a) in two levels contained neutralized pomegranate pulp with lime and non-neutralized pulp. The second factor (b) was vermicomposting medium which included 9 levels of pomegranate pulp composition (with levels of 0, 5, 10, 15, 20, 25, 30, 35 and 40 percentage of pomegranate pulp) and cow manure in three replications that formed a total of 54 experimental units. Also, *Eisenia fetida* worms were used in this experiment.

Preparing Mediums and Vermicomposting

Pomegranate samples were collected from Saveh gardens whose pulp was dried for a week. Then, the pulp was milled and half of it was neutralized with lime. Rotted cow manure was prepared from a certain livestock Research Institute in the University of Zabol. To measure the chemical properties of pomegranate waste and cow manure, 200g samples of this material were transported to the laboratory such that pH and EC in the extract of 1 to 10 with distilled water (Suthar, 2009), carbon percentage by dry burning method in electric furnace (Richard et al., 2009) and total nitrogen percentage by Kjeldahl method (Bartha and Pramer, 1965) were measured. Plastic containers with dimensions of 20 × 25 × 30 (cm^3) were prepared for vermicomposting mediums. Then, some pores were made at the bottom and the lids of containers for ventilation. Also, to avoid pouring mediums material out and exiting the worms, mesh fabric was placed with tiny pores inside containers. Then, the combination of pomegranate and cow manure waste dumped into the containers under the experimental design so that each of the test units had three kg mediums. After wetting mediums with water, ninety mature earthworms were put into each experimental unit. During the experiment, the daily moisture of mediums was set by weight at 70% and the growth chamber temperature at 25±2 °C (Kaplan et al., 1980; Loehr et al., 1985; Edwards, 2004).

It should be noted that the preliminary tests showed that earthworms were destroyed in the composition of 50% and higher in pomegranate pulp; therefore, 40% and lower combinations of pomegranate pulp were used to make vermicompost in this test.

Neutralization of Pomegranate Pulp With Lime

Most species of earthworms prefer neutral pH to slightly alkaline environment for growth and optimal activity (Pramanik et al., 2007). Due to the low pH of pomegranate pulp (Table 1), lime addition to pomegranate pulp was considered to increase the pH and optimize it for the growth and activity of earthworms. To produce neutralized acidity, 10.4 grams of lime were consumed per kilogram of pomegranate pulp. In order to create balance and uniformity of pH, lime was fully mixed with saturated pomegranate pulp and was placed for 24 hours and then, it was air-dried.

Numeration of the Number of Mature Worms, Infant Worms and Cocoons

To count the number of mature worms, infant worms and cocoons in three kg mediums, each of the fields was first thoroughly mixed and then 200 g samples were separated from the mediums for more accurate census count and then, the results were generalized to each experimental unit with the aid of binocular (Edwards, 1988; Edwards et al., 1998).

Measurement of the Percentage of Carbon and Nitrogen of Vermicompost at Ambient Temperature

To measure the organic carbon percentage, at first the samples were dried at 105 °C for 24 hours in an oven. After weighing, 2g samples were poured in the Chinese cruise and were put for six hours at 550 °C in an electric furnace. Samples were taken to desiccators after this period and after cooling, re-weighing and measuring weight loss, then the percentage of organic carbon samples were calculated (Richard et al., 2009). Total nitrogen was measured by Kjeldahl method. That is, first, 1 gram of sample was screened and put in Kjeldahl digestion pipes and acid and catalyst were added and after digestion, total N of samples was measured by titration (Bartha and Pramer, 1965).

Statistical Analysis

Statistical analysis of data was carried out using SAS software version 9.2 and the mean comparison was done by Duncan's multiple range test at P≤0.05.

RESULTS AND DISCUSSION

According to Table 1, pomegranate pulp pH is very acidic and highly saline as well. It seems that one of the main reasons to deter high percentage of fruit pulp and developmental activities of worms is acidic pH and salinity of these materials.

Table 1. Chemical characteristics of cow manure and pomegranate pulp

Neutralized Pomegranate pulp	Non-neutralized pomegranate pulp	Cow manure	
7.06	3.57	7.28	pH
3.22	3.08	0.67	EC (ds m^{-1})
53.46	53.61	31.12	TOC %
1.26	1.26	1.42	TN %
42.43	42.55	21.92	C/N

In the previous preliminary test, these factors caused all earthworms to be destroyed at levels of 50 percentages and higher of pomegranate pulp. According to Table 2, Analysis of variance for data showed that the main effect of (a) factor (neutralized pomegranate pulp with lime and non-neutralized pulp) was significant on the number and weight of mature worms, the number of infant worms and cocoons, total nitrogen percentage, carbon to nitrogen ratio at (P≤ 0.01). Also, the main effect of (b) factor (different levels of pomegranate pulp) was significant on all characteristics at (P ≤ 0.01). Moreover, the interaction effect between (a and b) factors on the number and weight of mature worms, total nitrogen percentage, carbon to nitrogen ratio was significant at (P ≤ 0.01), and on the number of cocoon and the number of infant worms was significant at (P ≤ 0.05).

The Number of Mature Worms

Means comparison showed that there was not any significant difference between neutralized and non-neutralized treatments in each percentage of pomegranate pulp in this respect with the exception of treatments of 25 and 30% pomegranate pulp; that is, neutralization compared to non-neutralization significantly increased this trait. Generally, with increasing the percentage of pomegranate pulp up to 20 and 25%, the number of mature worms enhanced. But, after these levels (20 and 25%), with increasing pomegranate pulp up to 40%, worms' population again declined. In addition, the highest and lowest numbers of mature worms were observed in treatment combination NP25 with 34 and P40 with 125 earthworms, respectively (Fig. 1).

Research shows that the population of earthworms usually increases as long as the food is not a limiting factor (Edwards et al., 2010). Moreover, if wastes are more carious, favourable conditions will be created to produce vermicompost and increase the number and weight of worms (Wood, 1998). It seems that the amount of pomegranate pulp for treatment combination NP25 is not enough to affect worms' population. On the other hand, according to the chemical properties of pomegranate pulp (Table 1), cow manure mixed with pomegranate pulp is not an appropriate food source for worms. Therefore, it is eaten by them over time and can be available as food for worms for more time and so they do not face with limited food resources.

Table 2. Variance analysis of effects of (a and b) factors on the studied trait in *Eisenia fetida* worms and vermicompost

CV %	Error	a×b	b	a	Variation sources	
	36	8	8	1	Df	
12.187	80.037	283.282**	6393.504**	1154.404**	Mature worms number	Mean-square
9.998	10.178	56.584**	1102.325**	110.653**	Mature worms weight	
9.439	691.055	1496.041*	33005.625**	68480.166**	Cocoon number	
9.765	5701.889	5722.125*	549923.458**	79580.195**	Infant worms number	
4.274	1.153	0.527^{ns}	61.782**	0.241^{ns}	TOC%	
2.705	0.001	0.027**	0.118**	0.140**	TN%	
3.710	0.414	9.603**	97.296**	28.588**	C/N	

^{ns},**, * denote non-significant and significant at (P≤0.01) and (P≤0.05), respectively.

a, b and a × b denote first factor (neutralized pomegranate pulp with lime and non-neutralized), the second factor (different levels of pomegranate pulp) and the interaction between them, respectively.

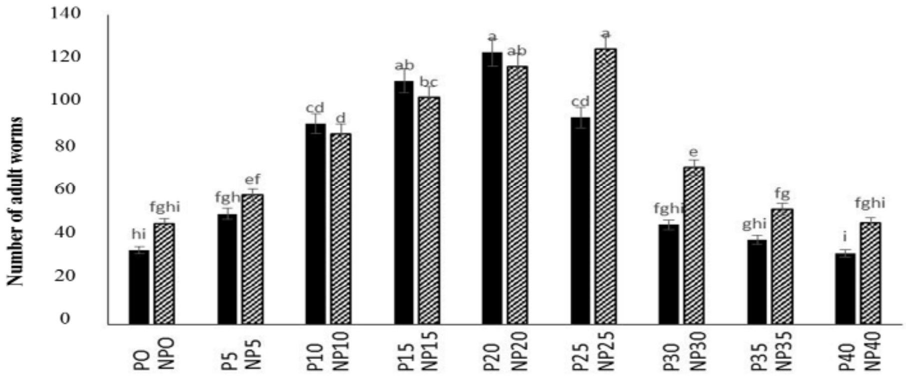

Fig. 1. Effect of different levels of pomegranate pulp and its neutralization with lime on the number of mature worms (The letter N represents neutralized pomegranate pulp with lime and Px represents the percentage of pomegranate pulp in the medium of the vermicomposting). Same letters represent no significant differences according to Duncan's test at ($P \leq 0.05$).

That's why most of the population of *Eisenia fetida* worms was observed in this combination. While the control (manure) was used for the nutritional desirability for earthworms (Banu et al., 2005; Garg et al., 2006) in a short period of time and then worms faced with food shortages and a significant number of them were killed. Yadav and Garg (2010) reported that the growth and reproduction of earthworms in vermicomposting are significantly affected by various factors including the type of waste, temperature, humidity, chemical composition, size and species of the earthworms. Therefore, one of the reasons for reducing the number of mature worms in P40 is chemical composition and a high percentage of pomegranate pulp that has acted as a limiting factor and caused a loss of more worms. Also, Ndegwa et al. (2000) stated that the C/N ratio raise in medium materials can be one of the reasons for reducing the number of earthworms, which is consistent with the results of this study because P40 treatment combination has the highest C/N ratio compared to other treatment combinations.

The Weight of Mature Worms

According to Fig. 2, means comparison shows that each percentage of pomegranate pulp of neutralized and non-neutralized treatments with lime are not statistically different with respect to this attribute, except for 25 and 30% of pomegranate pulp because neutralization increased this attribute compared to non-neutralization of pomegranate pulp. Generally, when pomegranate pulp percentage of the medium increased up to20 and 25%, the weight of mature worms also increased. After 20 and 25 %of pomegranate pulp, with increasing this pulp up to 40%, the weight of mature worms reduced. The highest and lowest weight of earthworms in the treatment NP25 was found with 53.02 g and P40 was observed with 13.76g, respectively. Aquino et al. (1994) stated that increase rate in biomass depends on population density and the type of food that worms consume. With regard to the figs. 1 and 2, the weight of worms is more influenced by their number in different mediums.

The Number of Cocoons

Despite non-significant differences between neutralized and non-neutralized at zero, 30 and 35 percentage of pomegranate pulp, neutralized treatments significantly increased this attribute compared to non-neutralized pulp at levels 5, 10, 15, 20, 25 and 40 percentage of pomegranate pulp. Also, the percentage of pomegranate pulp enhanced, and then the number of cocoons dropped so that the highest and lowest numbers of cocoons are observed with 406 numbers in NP0 treatment and 114 numbers in P40 treatment, respectively (Fig. 3). Shayanfar (2012) stated that most species of earthworms need to neutralize pH to slightly alkaline mediums. Kaplan et al. (1980) believed that the optimum pH for reproduction, growth and development of earthworms is between 7.5-8, and calcium carbonate (limestone) and egg shell can be used to increase the pH of acidic mediums (Munroe, 2007). Due to the fact that pomegranate pulp has very acidic pH (Table 2), non-neutralized pulps rather than neutralized pulps in the mixture with manure can further reduce medium pH and thus cause an unfavourable environment for proliferation and production of earthworms' cocoon.

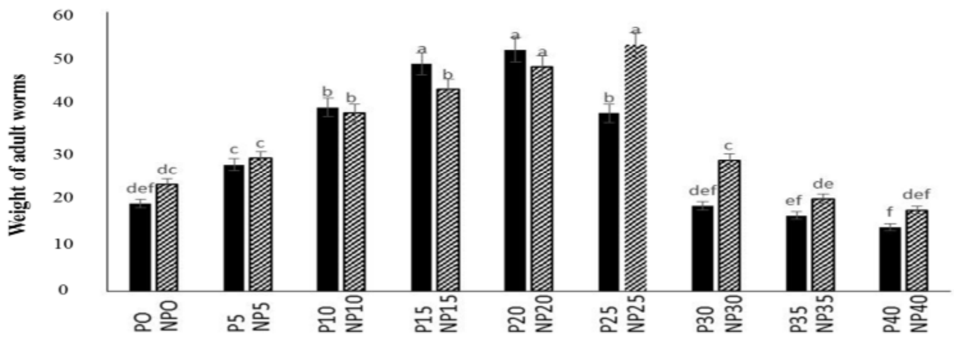

Fig. 2. Effect of pomegranate pulp and its neutralization with lime on the weight of mature worms (The letter N represents the neutralized pomegranate pulp with lime and Px represents the percentage of pomegranate pulp in the medium of the vermicomposting). Same letters represent no significant differences according to Duncan's test at ($P \leq 0.05$).

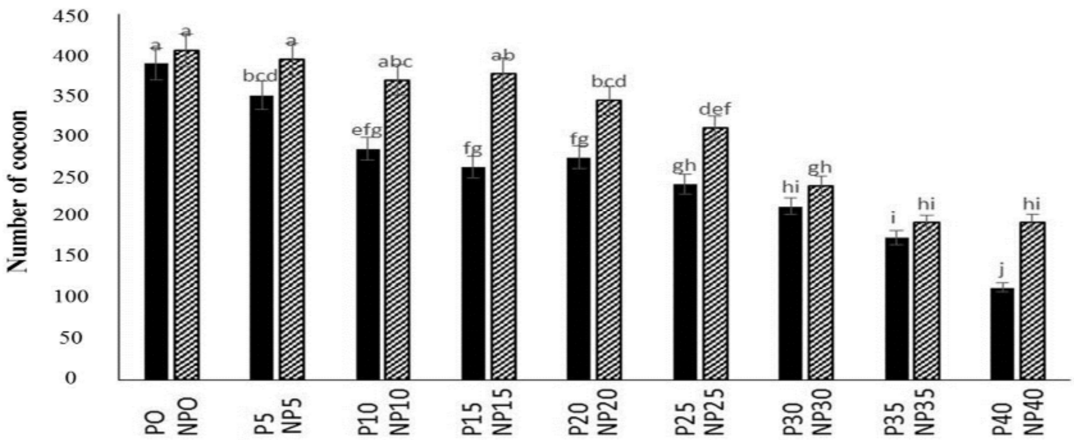

Fig. 3. Effect of different levels of pomegranate pulp and its neutralization with lime on the number of cocoon (The letter N represents the neutralized Pomegranate pulp with lime and Px represents the percentage of pomegranate pulp in the medium of the vermicomposting). Same letters represent no significant differences according to Duncan's test at ($P \leq 0.05$).

The number of cocoons produced by earthworms is an indicator of their reproduction and as the number of capsules gets higher, it shows that the optimal conditions have been provided for earthworms mating. Chauhan and Singh (2013) assessed the reproduction of *Eisenia fetida* worms and reported the highest amount of cocoon production in the cow manure medium mixed with straw and rice bran at a ratio of 1:1:1, respectively. Garg et al. (2006) examined *Eisenia fetida* earthworms breeding in different animal manure and drew a conclusion that cow manure is one of the best mediums in terms of the number of their cocoon production. Loh et al. (2005) reported that most cocoon productions of *Eisenia fetida* worms are produced in cow manure rather than sheep manure. Because NP0 only contains cow manure, so it has provided better conditions for reproduction and increase of cocoon population. Perhaps, the paucity of favourable food sources for worms and harmful chemical composition of pomegranate pulp also lead to the reduction of cocoon production in treatment P40, which more than other treatments, has weakened worms in the cocoon production.

Infant Worms' Population

According to Fig. 4, the means comparison shows that at all levels of pomegranate pulp with the exception of 40%, there were not significant differences between neutralized and non-neutralized treatments with respect to this attribute. But on average, pomegranate pulp neutralization with lime increased 10% of infant worms' population compared to non-neutralized pomegranate pulp. The infant worms' population also was fallen by increasing pomegranate pulp percentage so that the maximum and minimum number of infant worms was treated in treatment of NP0 with 1208 worms and P40 with 220 worms, respectively.

One of the best mediums for the growth and reproduction of *Eisenia fetida* worms is cow manure (Loh et al., 2005; Garg et al., 2006). But pomegranate pulp, due to some limiting chemical properties (Table 2), is not a suitable medium for the growth and proliferation of *Eisenia fetida* worms. Thus, increasing the percentage of pomegranate pulp makes trouble for the *Eisenia fetida* worms' proliferation as well. Infant worms (which are weaker than the mature worms) encounter very serious problems to grow or even survive, which ultimately reduces the infant worms in treatments whose pomegranate pulp percentage increases.

Nitrogen Percentage of Vermicompost

Means comparison showed that at levels of zero, 5, 10, 15 and 20 percentage of pomegranate pulp, neutralized treatments with lime compared to non-neutralized treatments did not have any significant difference in terms of this trait. But at levels of 25, 30, 35 and 40 percentage of pomegranate pulp, neutralized treatments significantly increased nitrogen percentage of produced vermicompost compared to non-neutralized treatments. In addition, the highest and lowest nitrogen percentage was observed in treatment of NP25 by 1.69% and P40 by 1.10%, respectively (Fig. 5).

Perhaps high nitrogen percentage in treatment of NP25 is due to crowded worms population and nitrogen discharge raise by worms in the medium. Also, due to very low pH of pomegranate pulp (Table 2), by increasing the percentage of pomegranate pulp, initial medium pH also reduces. However, most species of earthworms need neutral pH to slightly alkaline for optimum growth and activity (Shayanfar, 2012). It seems that at 25% and higher levels of pulp pomegranate, neutralization of pomegranate pulp provides a more appropriate pH medium than non-neutralization for the growth and activity of worms. So, nitrogen discharge of worms also increases which ultimately increases the nitrogen content of produced vermicompost.

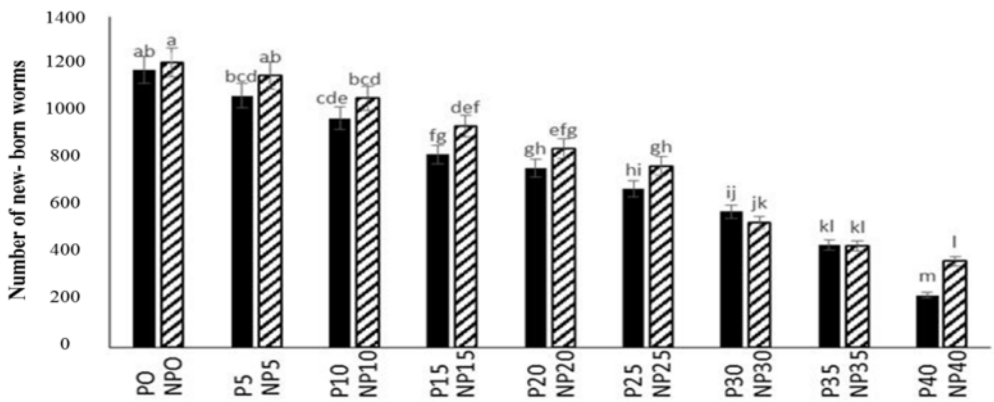

Fig. 4. Effect of different levels of pomegranate pulp and its neutralization with lime on infant worms' population (The letter N represents the neutralized pomegranate pulp with lime and Px represents the percentage of pomegranate pulp in the medium of the vermicomposting). Same letters represent no significant differences according to Duncan's test at (P≤ 0.05).

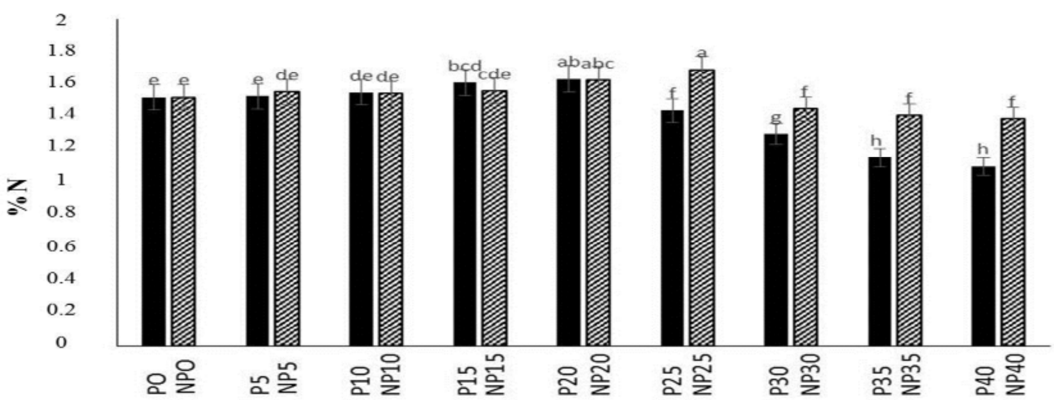

Fig. 5. Effect of different levels of pomegranate pulp and its neutralization with lime on total nitrogen percentage of vermicompost (The letter N represents the neutralized Pomegranate pulp with lime and Px represents the percentage of pomegranate pulp in the medium of the vermicomposting). Same letters represent no significant differences according to Duncan's test at (P≤ 0.05).

Organic Carbon Percentage

According to Table 3, the highest and lowest percentage of organic carbon were observed at level of 40% of pomegranate pulp with 30.32%and zero level of pomegranate pulp (control) with 20.83%, respectively. Overall, the carbon percentage of produced vermicompost has also increased by increasing the percentage of pomegranate pulp in mediums.

It is a fact that in initial mediums with enhancing pomegranate pulp, carbon percentage increases too (Table 2). Moreover, Prakash and Karmegam (2010) stated that the amount of carbon in the vermicompost depends on respiration and activity of earthworms and microorganisms in the medium that may be released in the form of CO_2. Atiyeh et al. (2000) reported that in vermicomposting process, the rapid decomposition of organic carbon compounds and CO_2 rapid withdrawal have led to weight loss of the final vermicompost. Perhaps the second reason for organic carbon reduction in P0 treatment (cow manure) is due to higher activity and feeding of worms in this medium, which causes more carbon releases out of medium in the form of CO_2 and also declined carbon content in produced vermicompost. Another reason for the high percentage of organic carbon in P40 is also probably due to the high percentage of pomegranate pulp in these mediums (that nutritionally is not desirable for earthworms) and so is not fully digested by earthworms during the 80 days. Thus, this factor which led to the highest percentage of carbon is observed in this medium.

The Ratio of Carbon to Nitrogen

According to Fig. 6, means comparison shows the levels of zero, 5, 10, 15, 20 and 25 percentage of neutralized pomegranate pulp compared to non-neutralized treatment were not significantly different in terms of this attribute; but, at 30, 35 and 40 percentage of pomegranate pulp, neutralized treatments significantly reduced the trait compared to the non-neutralized treatments. Overall, pomegranate pulp percentage increased, so C/N ratio also increased.

The highest and lowest C/N ratio were found in treatment of P40 with 27.87% and P0 with 13.51%. Viel et al. (1987) reported that the relative increase in total nitrogen and organic carbon loss as CO_2 can reduce C/N ratio. Mediums that have higher levels of pomegranate pulp content have high C/N as well; on the other hand, this medium is not favourable to feed the earthworms. The relative decomposition occurs less in this medium and less carbon releases in the form of CO_2 out of these mediums and ultimately increases the C/N ratio in produced vermicompost.

Table 3. Effect of pomegranate pulp mixed with cow manure on organic carbon content of vermicompost

P40	P35	P30	P25	P20	P15	P10	P5	P0	
30.32a	28.48b	27.39c	26.20d	24.83e	23.60f	22.61fg	21.86gh	20.83h	Organic carbon percentage

Same letters represent no significant differences according to Duncan's test at ($P\leq 0.05$).

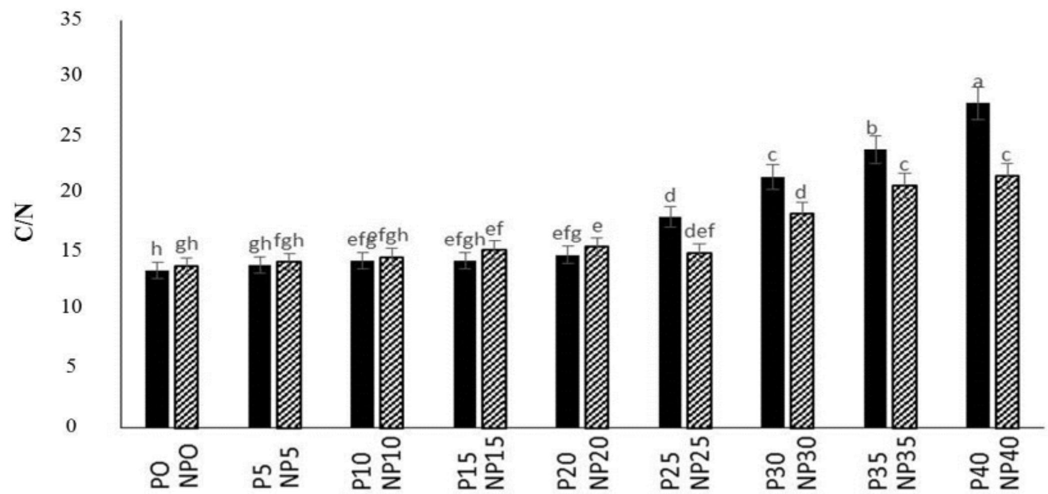

Fig. 6. Effect of different levels of pomegranate pulp and its neutralization with lime on carbon to nitrogen ratio in vermicompost (The letter N represents the neutralized pomegranate pulp with lime and Px represents the percentage of pomegranate pulp in the medium of the vermicomposting). Same letters represent no significant differences according to Duncan's test at ($P\leq 0.05$).

CONCLUSIONS

In general, it can be said that cocoon, population and biomass of *Eisenia fetida* worms reduced and carbon percentage and C/N ratio increased in vermicompost by increasing pomegranate pulp percentage in medium. Moreover, the use of neutralized pomegranate pulp compared to non-neutralized pulps has improved the measured attributes in *Eisenia fetida* worms and produced vermicompost as discussed above in detail.

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تاثیرترکیب درصدهای مختلف تفاله انارخنثی شده و خنثی نشده باکود گاوی بر ویژگی‌های کرم‌های *Eisenia ftida* و ورمی‌کمپوست

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واژه‌های کلیدی:
کرم خاکی
کوددامی
ضایعات انار
ورمی‌کمپوست‌سازی

چکیده- با تولید ورمی‌کمپوست از تفاله انار حاصل از کارخانجات علاوه برجلوگیری از آلودگی محیط زیست می‌توان باعث ایجاد اشتغال، تولید با ارزش افزوده و مانع از هدرروی انرژی و سرمایه کشور شد. این آزمایش به صورت فاکتوریل و در قالب طرح کاملاً تصادفی طراحی و اجرا شد. فاکتور اول (a) در دو سطح شامل تفاله انارخنثی شده با آهک و خنثی نشده بود. فاکتور دوم (b) بسترهای ورمی-کمپوست‌سازی که شامل ۹ سطح ترکیب تفاله انار (با سطوح ۰، ۵، ۱۰، ۱۵، ۲۰، ۲۵، ۳۰، ۳۵، ۴۰ درصد) وکود گاوی بود، که درسه تکرار مجموعا ۵۴ واحد آزمایشی را تشکیل دادند. کرم‌های خاکی مورد استفاده دراین آزمایش از نوع *Eisenia fetida* بود. درطول آزمایش رطوبت بسترها روزانه به صورت وزنی در ۷۰ درصد ودمای اتاقک رشد نیز در $25\pm2\ ^{\circ}C$ تنظیم شد. به‌طورکلی نتایج نشان دادکه با افزایش درصد تفاله انار بسترجمعیت کرم‌های نوزاد و پیله کرم‌های *Eisenia fetida* کاهش یافت ولی بیشترین جمعیت و زیست توده کرم‌های بالغ درسطح ۲۵ درصد تفاله انار مشاهده شد. همچنین با افزایش درصد تفاله انار بستر، درصد کربن آلی و نسبت C/N ورمی‌کمپوست افزایش یافت. بیشترین درصد ازت ورمی‌کمپوست نیز در سطح ۲۵ درصد تفاله انار مشاهده شد. تفاله انارخنثی شده نسبت به خنثی نشده نیز در اغلب موارد باعث بهبود صفات اندازه‌گیری شده درکرم‌ها و ورمی-کمپوست‌های تولید شده گردید.