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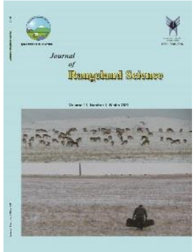

Research and Full Length Article:

Effect of Wheat Straw Biochar and Lignite on Nutritional Value of *Nitraria schoberi* and *Astragalus podolobus* in Greenhouse Condition

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Abstract. Most of rangeland soils are limited in their ability to supply adequate nutrients to plants. Soil conditioners have shown to alter soil fertility and plant characteristics. This investigation aims to evaluate the influence of two soil conditioners on nutrition value of *N. schoberi* and *A. podolobus.* For this, two separate experiments for each species were carried out in a greenhouse using a completely randomized design with three replications during 2018 and 2019. Treatments had four levels of Wheat Straw Biochar (WSB) as well as Lignite at rates of 0, 1.25%. 2.5% and 3.75% w/w added to clay loam soil. In the end of vegetative stage and before flowering, plant samples were taken and their Crude Protein (CP) and Acid Detergent Fiber (ADF) content were measured and then, Dry Matter Digestibility (DMD) and Metabolizable Energy (ME) were calculated. Data were analyzed by One-way analysis of variance (ANOVA) and the means were compared using Duncan's test. The results demonstrated that WSB addition had no effect on nutrition value of both species. By application of Lignite, CP content of *N. schoberi* enhanced up to 44.45% more than that for control. The effect of lignite addition on nutrition value traits was high for *N. schoberi*. But this material had no effect on *A. podolobus* quality traits. Based on our findings, application of lignite at 3.75 (w/w) was recommended to improve soils of rangeland for cultivation of *N. schoberi* in dry-land plantation projects or the conversion of dry lands to arable pastures.

Key words: Biochar, Nutritional value, Plant species, Growth, Range improvement

Introduction

N. schoberi and *A. podolobus* species are usually used for rangeland improvement (Moghimi, 2006). Nutrition value of most species changes during phenological stages (Ahmadi *et al.*, 2016). Zare *et al.* (2019) showed that crude protein (CP), metabolizable energy (ME) and dry matter digestibility (DMD) of *Salsola tomentosa* and *Salsola yazdiana* were decreased during growth stages. The nutrition value of rangeland species change during different phenological stages (Ahmadi Bani *etal.*, 2014), so, knowing their nutrition value is crucial to supply a rational diet to livestock and determine stocking rate and grazing time in rangelands (Ashrafzadeh *et al.*, 2019).

Optimal growth of rangeland plants and achieving maximum forage quantity and quality require a sufficient amount of supplementary fertilizers in the soil (Shahrasbi *et al.*, 2015). This object can be achieved by chemical, organic, and biological amendments and soil conditioners (Shahrasbi *et al.*, 2015).Chemical conditioners will certainly have adverse impact on environment. Therefore, it is important to discuss using another type of conditioners such as biological conditioners produced by the decomposition of products such as plant tissue, sewage sludge and organic fertilizers from municipal waste (Behnam *et al.*, 2017).

Meanwhile, Biochar (BC) as a soil conditioner has been paid attention by researchers (Behnam *et al.*, 2017). BC is a highly stable organic compound produced by burning of organic residues including agricultural, forest and municipal waste such as wood, wastewater, green waste, poultry waste, pine sheets, rice husk, pulp, and other pulses (Hu *et al*., 2013). BC has high stability and is produced for waste management, climate change reduction, energy production and soil properties improvement (Khadem *et al*., 2018). Furthermore, it affects soil physical (soil structure, bulk density and hydraulic conductivity), chemical (pH, cation exchange capacity and organic matter content) and biological (microbial diversity, enzymatic activity and soil microbial population) properties and fertility.BC increases plant yield by providing a major part of its necessary elements. It is mostly reported that BC improves soil properties (Khadem *et al*., 2018).

Hafeez *et al.* (2017) investigated the effects of corn BC on seed emergence, plant growth, carbohydrates and protein content of soybean leaf under drought stress. They observed a significant increase in carbohydrates content. However, BC had no significant effect on protein content and germination rate than control group.

Teodoro *et al*. (2019) used BC compost to study soil physical and chemical properties as well as the growth of *Lolium perenne* and *Eruca sativa* in a metal-contaminated soil. They found that the weaker growth of the plant in the control soil was likely due to the toxicity of the metals and this was especially evident in the case of *E. sativa*. It has also been shown that metal exposure causes a reaction with oxygen in the plant's metabolizable system and it changes the amount of plant protein and carbohydrates (Teodoro *et al*., 2019).

Rehman *et al.* (2019) used the rice husk BC to enhance the growth of *Boehmeria nivea* and its morphological characteristics in copper-contaminated soil. They stated that using rice husk BC 10% had significantly increased chlorophyll content, plant height and stem diameter of *Boehmeria nivea*.

Huy *et al.* (2013) used the rice husk BC to increase production and growth of *Brassica chinensis*, *Brassica pekinensis*, *Brassica juncea* and *Ipomoea aquatic*. They demonstrated that increasing BC application rate from 0 to 5 kg/m^2 led to a linear increase in species biomass. Moreover, the mean of CP for leaf and stem increased from 13.7% to 18.1% and 7.23% to 9.16%, respectively.

Zainul *et al.* (2017) used “compost BC” and “mixed compost and compost BC” to increase the growth and photosynthetic activities of *Phragmites karka*. They observed that only compost BC increases the growth of the species.

In many rangelands, soil receives low input and tends to be degraded, poorly managed or not managed at all (Niknahad-Gharmakher *et al.*, 2015_b). Despite increasing use of BCs in agricultural fields, a few studies have been conducted to investigate the effects of this conditioner on nutritional indices of rangeland plants. Increasing vegetation cover and forage production with high nutritional value are of the important goals of rangelands biological improvement plans. Regarding the increasing trend of degraded lands improvement in the world, the use of suitable species will be of great importance (Niknahad-Gharmakher *et al.*, 2015_a). *A. podolobus*, belonging to the family papilionaceae (*Astragalus* genus), is one of the most valuable species without thorns and is well used in the conversion of dry land to arable pastures in terms of the nutritional value of plant and soil conservation aspects. *N. schoberi*, belonging to the family Zygophyllaceae (*Nitraria* genus), is a multiple use species used for soil stabilization and forage production in salty lands (Moghimi, 2006). Therefore, this study investigated the alteration of nutritional value of *N. schoberi* and *A. podolobus* under wheat straw biochar (WSB) and lignite, a type of coal that is abundantly present in all coal mines as tailing or thermal coal, an addition to make the best management decisions and select appropriate species and soil conditioner.

Materials and Methods

A clay loam soil was collectedfrom the topsoil 0-15 cm at Incheh-boroun winter rangeland in Golestan province, Iran. WSB derived from irrigated wheat straw was produced using an electric furnace at 400°C, and residence time of six hours in Noavaran Zist Bonyan Avisa Company in Ahvaz, Iran. Lignite was also purchased from Kuhbanan mine in Kerman province, Iran. Soil subsamples (three replicates per treatment) were placed in pots (25.5 cm diameter and 24.5 cm height) in a greenhouse. WSB and lignite were uniformly added at a rate of 0 (control), 1.25%, 2.5% and 3.75% (dry weight basis).

Finally, the seedling of *N. schoberi* and *A. podolobus* species, which is provided from natural resource department of Golestan province, was planted in the pots. Plant samples were clipped manually with special scissors in the end of vegetative stage and before flowering, dried at 70°C in oven and ground pass through 100 micron screen. Nitrogen (N) was measured by an automatic Kjeldahl 1100 machine (BEHR Company, Germany) and acid detergent fiber (ADF) was determined using Fibertec 2010 (FOSS Company, Germany) according to AOAC (2000). The crude protein (CP), dry matter digestibility (DMD), and metabolizable energy (ME) were estimated by the following equations, respectively.

Equation1

$$CP = ۶.۲۵ \times N\%$$

Equation2

$$DMD\% = ۸۳.۵۸ - ۰.۸۲۴\ ADF\% + ۲.۲۶۲\ N\%$$

Equation3

$$ME\left(\frac{MJ}{KgDM}\right) = ۰.۱۷\ DMD\ \% - ۲$$

Statistical analysis

Differences among levels of treatments (WSB and lignite) for each species were analyzed by One-way analysis of variance (ANOVA) using the $SPSS_{21}$ statistical software and the means were compared using Duncan's test. Microsoft Excel was used to draw the figures.

Results

Nitraria schoberi

The One-way ANOVAs were made to test the effects of WSB and lignite rate on forage quality traits of *N. schoberi* in greenhouse condition. Result demonstrated a significant effect ($p < 0.05$) of WSB and lignite addition doses on all of quality traits of this species (Table 1).

The results obtained on the CP content of *N. schoberi*as influenced by different levels of lignite (Fig 1.) showed the increasing rates of lignite application. The corresponding CP values were 10.58%, 12.24% and 12.51% in pots with lignite at 1.25%, 2.5% and 3.75% (w/w), respectively. All WSB addition levels caused no significant alteration in the CP content of *N. schoberi*as compared with the control while a significant decrease (9.71%) relative to the control (8.66%) was recorded in the pots receiving 1.25% (w/w) WSB.

The results revealed that lignite addition altered the values of ADF across all the incorporation doses which were found to be directly proportional to the rate of addition (Fig.1). Among lignite treated pots, the lowest ADF value (12.45%) was observed in pots receiving 3.75% (w/w) lignite, which was significantly lower than the control. Different levels of WSB addition caused no significant change in the percentage of ADF (Fig.2).

The results obtained on variation of DMD content for *N. schoberi*are given in Fig.1. Incorporation of lignite at 3.75% (w/w) caused significant increase (DMD, 77.84%) in the value of DMD compared with the control (DMD, 75.62%) while lignite rate in 1.25% (w/w) had no significant effect on (DMD, 73.4%). Different doses of WSB application caused no significant effect on DMD as compared with the control.

The results obtained on ME of *N. schoberi*as influenced by different doses of lignite and WSB are presented in Fig. 1. Among lignite added treatments, the highest ME (11.23 MJ/kg DM) was observed in 3.75% (w/w) application rate and the lowest value 10.47 MJ/kg DM was observed in 1.25% (w/w) addition dose (Fig.1). Lignite addition at 3.75% (w/w) caused significant increase in ME as compared with the control (ME, 10.85 MJ/kg DM) while application at 1.25% (w/w) caused significant decrease relative to the control.

Different levels of WSB incorporation rates caused no significant change in the ME as compared with the control although there was a significant difference between WSB 1.25% and 2.5% (w/w) added pots (ME, 10.69 and 10.87 MJ/kg DM).

Table 1. Analysis of variance of four forage quality traits of *N. schoberi* in lignite and WSB added pots

SOV	DF	MS			
		CP	ADF	DMD	ME
Between groups	6	6.31**	6.25**	5.36**	0.15**
Within groups	14	0.05	0.41	0.28	0.008
Total	20				

**=significant at 1% probability level

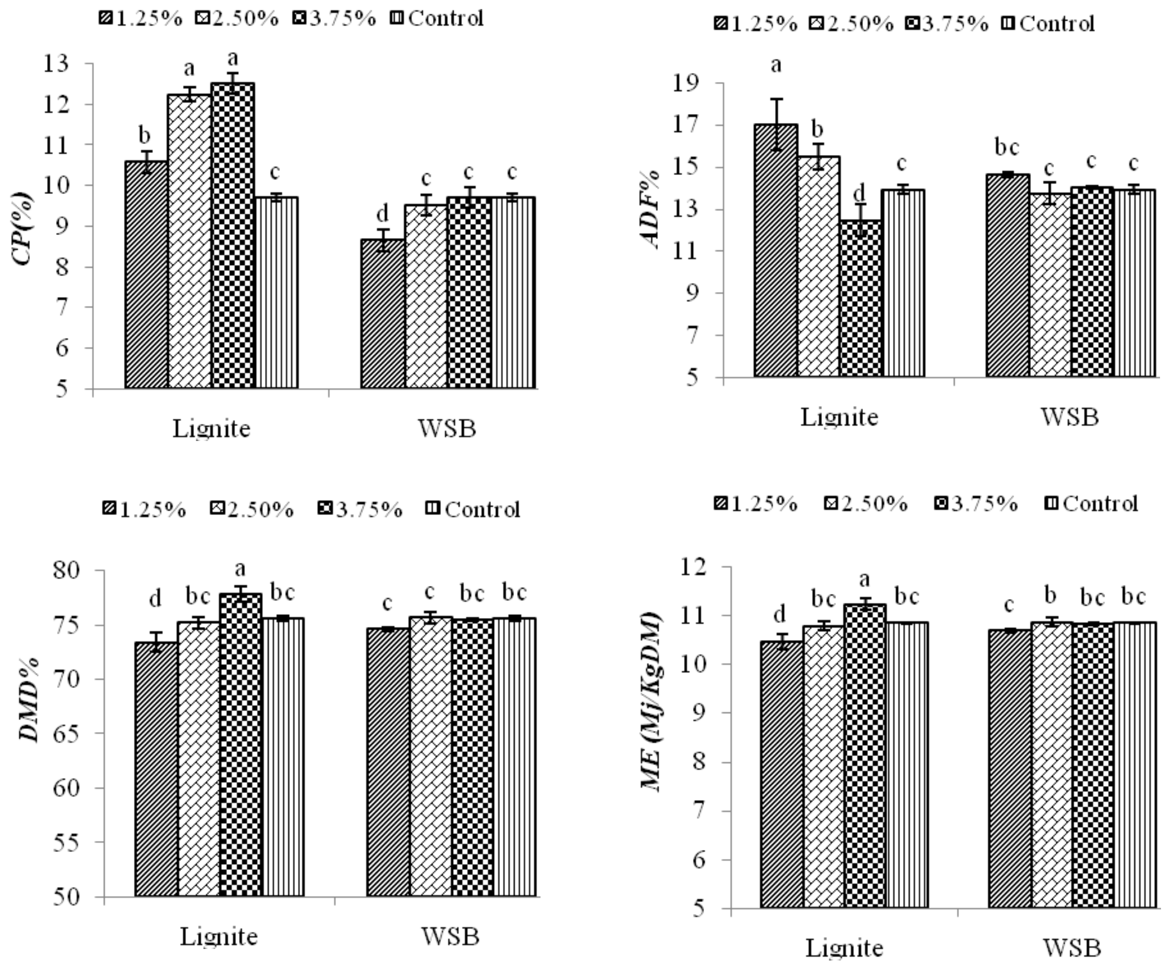

Fig.1. Effect of WSB and lignite on CP and ADF DMD% and ME (MJ/kgDM content of *N. schoberi*
Means in each column followed by similar letters are not significantly different at 5% probability level using Duncan Test

Astragalus podolobus

The One-way ANOVAs were made to test the effects of WSB and lignite rate on forage quality traits of *A. podolobus* in greenhouse condition. Result demonstrated a significant effect ($p< 0.05$) of WSB and lignite addition doses on all of quality traits of this species (Table 2).

The results revealed that lignite addition significantly increased CP content of *A. podolobus* across all the application levels which were found to be directly proportional to the rate of incorporation.The CP% was increased from 6.73% in the control to 8.04%, 9.09% and 8.83% in pots with lignite at 1.25%, 2.5% and 3.75% (w/w). Different WSB addition rates caused to diverse variation in the CP content of *A.podolobus*. A significant higher value of CP content (CP, 7.34%) was observed in treatment receiving 3.75% (w/w) WSB relative to the control. WSB application at 1/25% and 2.5% (w/w) caused no significant effect on CP% (Fig2).

Among lignite incorporated pots, only application rate at 3.75% (w/w) significantly increased ADF of *A. podolobus* (ADF, 21.7%) relative to the control (ADF, 16.35).

A significant lower DMD value (DMD, 68.89%) was observed in treatment receiving 3.75% lignite (Fig.2) but had no significant relationship with control. For WSB, all treatments had lower values than control and application of WSB decreases both DMD and ME (Fig.2).The result of ME was similar to DMD and lignite application rates had no significant effect as compared with the control. All WSB addition doses caused significant decrease in the value of ME. The largest decrease was noted in treatment receiving 2.5% WSB (Fig.2).

Table 2. Analysis of variance of four forage quality traits of *A. podolobus* using lignite and WSB added pots

SOV	DF	MS			
		CP	ADF	DMD	ME
Between groups	6	6.18**	67.33**	57.28**	1.65**
Within groups	14	0.07	2.91	1.97	0.05
Total	20				

**=significant at 1% probability level

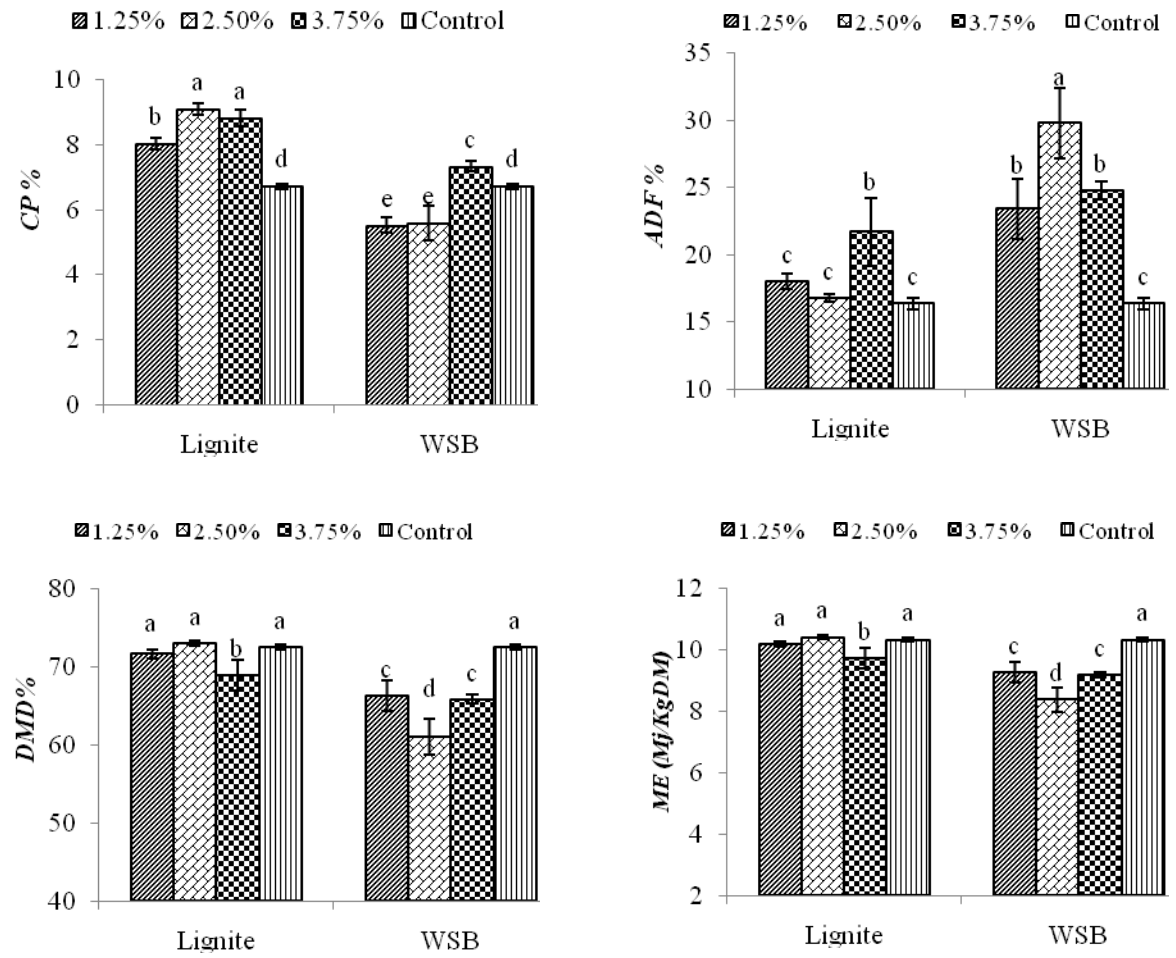

Fig.2. Effect of WSB and lignite on CP and ADF DMD% and ME (MJ/kgDM content of of *A. podolobus*
Means in each column followed by similar letters are not significantly different at 5% probability level using Duncan Test

Discussion

Lignite amended pots in this study showed significant increase in CP content of *N. schoberi*. and *A. podolobus* while WSB addition caused no effect on CP content in both species (except WSB 3.75% added CP% in *A. podolobus*). Application of lignite in pots enhanced CP% of *N. schoberi* and *A. podolobus* by 44.45% and 35% higher than that for control, respectively. The results of lignite application on CP% of *N. schoberi* and *A. podolobus* were in agreement with Husk and Major (2011) who reported that using BC may increase soybean biomass, and its CP content up to 17%. Since CP is derived directly from nitrogen, it can be concluded that the BC has a main role in improving plants nitrogen content (Chan *et al*., 2007). It has been reported that nitrogen content of the legumes increase in the presence of BC (Rondon *et al*., 2007). Studying the impact of waste sludge BC on the forage quality of *Hyparhenia hirta* demonstrated that application of BC in the soil had increased CP value of (16.2%) than that for control (9.4%) (Hossain *et al.*, 2015).

According to the results, lignite addition at 1.25% and 2.5% significantly increased ADF content of N. *schoberi* and only its application at 3.75% significantly decreased ADF percent of this species (10.5% lower than control). WSB incorporation caused no change in ADF content of *N. schoberi*. In the case of *A. podolobus*, all WSB application doses clearly increased its ADF content similarly for lignite, and only addition of 3.75% to the soil had increased ADF. In contrast to our result for *A. podolobus,* Husk and Major (2011) showed that the soybean ADF content slightly decreased (from 37.98% to 36%) after BC addition. Hossain *et al*. (2015) reported that the ADF of *Hyparhenia hirta* in control treatment and waste sludge BC were 40% and 35.5%, respectively. These findings in addition to our results suggest that different BCs have diverse effects on different species.

Only lignite addition at 3.75% significantly increased DMD and ME of *N. schoberi* and other doses of lignite and all added WSB levels had no effect on the mentioned forage quality traits. In the case of *A. podolobus*, all added levels of WSB and lignite at 3.75% significantly decreased DMD and ME of this species. Alberto *et al*. (2018) reported that different BC treatments had no significant effect on DMD of *Avena sativa*. Similar results were reported by Sánchez Gutierreza *et al*. (2014) and Barnes (1990).

In this regard,7% of CP, 50% of DMD and 8 MJ of ME/Kg DM have been recommended as forage critical limits to keep grazing livestock in the rangelands (Arzani *et al*., 201۴; Holechek *et al*., 2005). Our results revealed that both of studied species have these criteria. So, these species are suitable for using in rangeland improvement projects. Due to the significant positive effect of lignite incorporation on forage quality of *N. schoberi*, its application is recommendable for plantation of this species. WSB application had no effect or negative effect on the quality traits of both species, so its application in *N. schoberi* and *A. podolobus* plantation project cannot be recommended.

Among ecological factors, climatic and soil factors play an important role in determining plant habitat. Soil properties (especially soil texture) are effectively involved in the establishment and growth of plant species (Jafari *et al.*, 2003 and Aslani *et al.*, 2013). The different responses of studied species (especially *A. podolobus*) to the different soil conditioners indicate that in extensive plantation programs, environmental characteristics of desired area should be considered.

Conclusion

Both of studied species have acceptable forage quality. Our results revealed that *N. schoberi* efficiently responds to soil conditioner addition as compared with *A. podolobus*. Using lignite at 3.75% (W/W) is recommended in *N. schoberi* plantation projects in winter rangelands of Golestan province, Iran. Moreover, the results of this study could be useful in the conversion of dry lands to arable pastures.

References

AhmadiBeni, M., Niknahad-Gharmakher, H., Azimi, M., Maramaei, M.G., 2014.Investigation of forage quality of *Vetiveria zizanioides* in semi-steppe region of Maravehtappeh, Golestan province, Iran. Journal of Rangeland Science, 4(4): 287-297.

Ahmadi, A., Gomaryan, M., Toranjzar, H., Ahmadloo, H., 2016. Changes in chemical composition and nutritive value of for halophyte shrubs at three phonological stages (Case study: marginal rangeland of Mighan playa). Journal of Rangeland, 10(1): 41-52. (In Persian).

Alberto, E.C., Resendez, A.M., Carrillo, M.G., Quiroga Garza, H.M., Garcia, O.A., 2018. Influence of biochar applied to soil on yield and quality attributes of fodder oats. Revista Terra Latinoamericana, 36(8): 221- 228.

Arzani, H., Motamedi, J., Jafary, M., Farahpour, M., Zarechahooki, M., 2014. Classification of forage quality index highland ranglands of Taleghan. Journal of Range and Desert Research, 20(2): 250-271. (In Persian).

Ashrafzadeh, M., Niknahad-Gharmakher, H., Saharkhiz, M.J., Ghorbani-Nahoji, M. Heshmati, Gh., 2019. Breaking seed dormancy of *Clematis ispahanica* and its optimum planting depth and density (Case study: Bavanat, Fars province). Journal of Range and Desert Research, 26 (3): 629-639. (In Persian).

Aslani, F., Niknahad, H., Fattahi,B., akbarloo, M. 2013. An investigation on the effects of soil factors on the distribution and density of two unwanted species of *Rosa persica* and *Euphorbia macroclada* in Lashgardar rangelands of Hamedan province. Journal of Plant Ecosystem Conservation, 1 (2): 43-58 (In Persian).

AOAC., 2000. Official methods of analysis. 7th Edition, Animal feed, chapter 4, p.54: Arlington: AOAC International.

Barnes, R.F., 1990. Biotechology in tall fescue impovement. pp. 1-12. In: M. J. Kasperbauer (ed.). Importance and problems of tall fescue.CRC Press. Boca Raton, FL, USA.

Behnam, H., Farokhiyanfirozi, A., Moezzi, A., 2017. Effect of biochar and compost sugarcane bagasse on some soil mechanical properties. Journal of water and soil conservation, 23 (4): 235-250. (In Persian).

Chan, K.Y., Van Zweiten, L., Meszaros, I., Downie, A., Joseph, S., 2007. Agronomic values of green waste biochar as a soil amendment. Soil Research, 45: 629-634.

Hafeez, Y., Iqbal, S., Jabeen, K., Shahzad, S., Jahan, S., Rasul, F., 2017. Effect of biochar on seed germination and seedling growth of Glycine max (L.)MERR.under drought stress. Journal of Botany, 49: 7-13.

Holechek, J.L., Pieper, R.D., Herbel, C.H., 2005. Range management principles and practices, Prentice Hall, Englewood Cliff, 587P.

Hossain, M.K., Vladimir Strezov, V., Lester McCormick, L., Peter F., Nelson, P.F., 2015. Wastewater sludge and sludge biochar addition to soils for biomass production from *Hyparrhenia hirta*. Journal of Ecological Engineering, 82: 345-348.

Hu, L., Cao, L., and Zhang, R., 2013. Bacterial and fungal taxon changes in soil microbial community composition induced by short-term biochar amendment in red oxidized loam soil. World Journal of Microbiology and Biotechnology, 30: 1085-1092.

Husk, B., and Major, J., 2011.Biochar commercial agriculture field trial in Quebec, Canada–Year Three: Effects of biochar on forage plant biomass quantity, quality and milk production. IBI [accessed 2018 Sep1]. http://www.blue-leaf.ca/main-en/report_a3.php

Huy, S., Borin, K., Preston, T.R., 2013.Effect of different levels of biochar on the yield and nutritive value of Celery cabbage (*Brassica chinensis*), Chinese cabbage (*Brassica pekinensis*), Mustard green (*Brassica juncea*) and Water spinach (*Ipomoea aquatica*). Livestock Research for Rural Development, 25(1): 57-64.

Jafari,M., Niknahad,H., Erfanzadeh, R.2003. Study of the effect of Haloxylon species on soil physicochemical properties and vegetation of Hosseinabad, Qom province.Biaban 8: 152-162. (In Persian).

Khadem, A., Raiesi, F., Besharati, H., 2018. A review of the effects of biochar application on soil physical, chemical and biological properties. Journal of Land Management, 5(1): 13-30. (In Persian).

Moghimi, J., 2006. Introducing some important species of rangeland. Aaron Press, Pages 669P. (In Persian).

Niknahad-Gharmakher, H., Mohammadi Gonbadi, A., Bairam Komaki, C., Honardoust,F. 2015. Determination of Suitable Lands for Sowing Alkaligrass*Puccinelliadistans* (Case Study: Agh-Ghala Rangelands, Golestan Province, Iran). Journal of Rangeland Science, 5(1):1-8.

Niknahad-Gharmakher, H., JafariFoutami, I., Sharifi,A. 2015. Effects of grazing exclusion on plant productivity and carbon sequestration (Case study: Gomishan rangelands, Golestan province, Iran). Journal of Rangeland Science, 5(2):122-134.

Rondon, M.A., Lehmann, J., Ramirez, J., Hurtado, M. 2007. Biological nitrogen fixation by common beans (*Phaseolus vulgaris* L.) increases with bio-char additions. Biology and Fertility of Soils, 43: 699-708.

Rehman, M., Liu, L., Bashir, S., Saleem, M.H., Chen, C., Peng, D., Siddique, K.H. 2019. Influence of rice straw biochar on growth, antioxidant capacity and copper uptake in ramie (*Boehmeria nivea* L.) grown as forage in aged copper-contaminated soil. Plant Physiolgy Biochemistry, 138:121–129.

Sanchez Gutierreza, R.A., Gutierrez Banuelos, H., SernaPereza, A., Gutierrez Luna, R., Espinoza Canales, A., 2014. Yield and forage quality of oats varieties under rainfed conditions in Zacatecas, Mexico. Revista Mexicana de CienciasPecuarias, 5(2): 131-142.

Shahrasbi, S., Emam, Y., Ronaghi, A., Pirasteh-Anosheh, H., 2015. Effect of drought stress and nitrogen fertilizer on grain yield and nitrogen use efficiency of wheat (*Triticum aestivum* L. cv. Sirvan) in Fars province, Iran. Journal of Crop Sciences, 17 (4): 349-363. (In Persian).

Teodoro, M., Trakal, L., Gallagher, B.N., Simek, P., Soudek, P., Pohorely, M., Beesley, L., Jacka, L., Kovar, M., Seyedsadr, S., Mohan, D., 2019. Application of co-composted biochar significantly improved plant-growth relevant physical/chemical properties of a metal contaminated soil. Chemosphere, 242: https://doi.org/10.1016/j.chemosphere.2019.125 255.

Zainul, A., Werner, K.H., Bernhard, H., GUL Bilquees, G., and Ajmal, K.M., 2017. Impact of a biochar or a compost-biochar mixture on water relation, nutrient uptake and photosynthesis phragmites karka.Pedosphere. https://doi.org/10.1016/S1002-0160 (17)60362-X.

Zare, M., Zandi Esfahan, E., Ghorbani, A., 2019. Forage quality of *Salsola yazdiana* and *S. tomentosa* in different growth stages in saline desert of Yazd province, Iran. Journal of Rangeland Science, 9(2): 104- 113.

اثر بیوچار کاه‌گندم و لیگنیت معدنی بر ارزش تغذیه‌ای گونه‌های گیاهی *Nitraria schoberi* و *Astragalus podolobus* در شرایط گلخانه‌ای

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چکیده. توانایی اغلب خاک‌های مرتعی جهت فراهم نمودن مواد مغذی کافی برای گیاهان محدود است. اصلاح کننده‌های خاک حاصلخیزی خاک و خصوصیات گیاهان را تغییر می‌دهند. تحقیق حاضر به منظور ارزیابی اثرات دو اصلاح کننده خاک بر ارزش‌غذایی گونه‌های *N. schoberi* و *A. podolobus* در قالب طرح کاملا تصادفی در سه تکرار در شرایط گلخانه‌ای طی سال‌های ۲۰۱۸ و ۲۰۱۹ انجام شد و بیوچار پوشال گندم (WSB) و لیگنیت در سطوح ۰(شاهد)، ۱/۲۵٪، ۲/۵٪ و ۳/۷۵٪ وزنی به یک خاک رسی-لومی اضافه شدند. پس از برداشت نمونه‌های گیاهی در انتهای مرحله رشد رویشی و پیش از گلدهی، محتوی پروتئین خام (CP) و الیاف محلول در اسید (ADF) آنها اندازه‌گیری شده، قابلیت هضم ماده خشک (DMD) و انرژی متابولیسمی (ME) آنها محاسبه شدند. تجزیه و تحلیل آماری داده ها از طریق تجزیه واریانس یک طرفه (ANOVA) و با استفاده از نرم افزار آماری$SPSS_{21}$ صورت پذیرفت و مقایسه میانگین ها از طریق آزمون دانکن انجام شد. نتایج نشان داد که افزودن بیوچار پوشال گندم (WSB) اثر معنی‌داری بر شاخص‌های ارزش‌غذایی گونه‌های مورد مطالعه نداشت. در گلدان‌های تیمار شده با لیگنیت، محتوی پروتئین خام گونه *N. schoberi* در مقایسه با شاهد ۴۴/۴۵٪ افزایش یافت. اثرات افزودن لیگنیت بر شاخص‌های ارزش‌غذایی در گونه *N. schoberi* مشهودتر بود. بر اساس یافته های تحقیق حاضر، کاربرد لیگنیت در سطح ۳/۷۵٪ وزنی جهت اصلاح خاک مراتع اراضی خشک بمنظور کاشت *N. schoberi,*و یا تبدیل اراضی خشک به چراگاه های قابل کاشت توصیه می‌شود.

کلمات کلیدی: بیوچار، ارزش غذایی، رشد، گونه گیاهی، اصلاح مرتع