European Journal of Academic Essays 2(6): 59-67, 2015
ISSN (online): 2183-1904
ISSN (print): 2183-3818
www.euroessays.org

Evaluation of Energy Indices on Different Substrates of Oyster Mushroom Production

<Anbarestani, Leila>[1], <Asoodar, Mohamad Amin>[2], <Abas, Abdoshahi>[3], <Mokhtar, Heidari>[4]

[1] M-Sc. Mechanization, Engineering, Student of Khuzestan, Ramin Agriculture and Natural Resources University of Khuzestan, Ahvaz, Iran
anbarestani.leila@gmail.com

[2] Professor, Department of Agricultural Machinery and Mechanization Engineering, Khuzestan, Ramin Agriculture and Natural Resources University of Khuzestan, Iran
asoodar@scu.ac.ir

[3] Assistant Professor, Department of Agricultural Economics, Khuzestan, Ramin Agriculture and Natural Resources University of Khuzestan, Ahvaz, Iran
ahmadreza1378@yahoo.com

[4] Assistant Professor, Department of Agriculture Horticulture, Khuzestan, Ramin Agriculture and Natural Resources University of Khuzestan, Ahvaz, Iran
moky heidari@yahoo.com

Abstract: Mushrooms production is important in Iran due to the economic benefits of it; every year a significant amount of agricultural products become wasted which can be process to be used as the bed for mushrooms cultivation. The aim of this study was to determine energy consumption pattern and measure the benchmark of the efficiency for oyster mushroom production. In order to increase profitability, reduce energy consumption and produce a higher quality of mushroom an experiment was conducted using completely randomized factorial design, at the Research station of Ramin Faculty of Agriculture and Natural Resources University of Khuzestan in 2014. Treatments were included three different seeding beds, such as wheat straw, palm fibers and bagasse. Three dietary supplements included, soybean meal, canola meal, poultry manure and without food dietary supplement. Energy indicators (included energy efficiency, productivity, and power input) were measured Results showed that Fuel with 64.94 percent, was the most widely used energy inputs. Palm fibers bed showed less energy consumption, 176.29 (MJm^{-2}), than bagasse 454.04 (MJm^{-2}) and wheat straw 205.95 (MJm^{-2}). Palm fibers bed with 0.33 (MJm^{-2}), showed more efficient energy compared to other beds. The highest productivity belonged to palm fibers bed supplemented with the poultry manure and rapeseed meal 0.099 and 0.097 (MJm^{-2}).

Key Words: Energy Indices, Oyster Mushroom, Different Substrates

1. Introduction

The Oyster mushroom (*Pleurotus ostreatus*), is one of the most appreciated mushroom due to its very good taste, high nutritional and medicinal values. It has also been found to exhibit strong anti-inflammatory and immune-modulatory properties due to their chemical composition mushrooms are good sources of protein, vitamins and minerals. There are known to have a broad range of uses both as food and medicine. [1] Oyster mushroom is popular and considered a nutritious food in Swaziland but its cultivation has long been neglected, because most of the mushrooms consumed locally are picked from the wild. However, awareness in oyster mushroom cultivation in Swaziland has significantly increased since 2001, when the queen mother initiated a pilot project on mushroom production in conjunction with the Ministry of agriculture and cooperatives aimed at poverty alleviation and women empowerment through job creation in the rural areas.

Oyster mushroom can be grown on various substrates including paddy straw, maize stalk cobs, vegetable plant residues, bagasse and etc. [2] and this has been reported to influence its growth, yield and composition. [3] However, an ideal substrate should contain nitrogen (supplement) and carbohydrates for rapid mushroom growth. [4] The cultivation of oyster mushroom is gaining importance in tropical and subtropical regions due to its simple way of cultivation and high biological efficiency. [5] Oyster mushrooms have been traditionally produced using the outdoor log technique (Anonymous, 2008). thereby

Corresponding Author: Anbarestani, Leila

eliminating substrate sterilization. The technology of large scale mushroom production is a recent innovation and the establishment of laboratories for research on mushroom growing and the use of pure spawn culture resulted in rapid and increased production of mushrooms worldwide. [6] The substrates for cultivating edible mushrooms e.g. *Pleurotus ostreatus*, has been reported to require varying degrees of pretreatment in order to promote growth of the mushroom mycelium to the exclusion of other Micro Organisms. [7] The methodology for composting agricultural residues, followed by pasteurization, which could be carried out in different ways. [8]

Agriculture itself is an energy user and energy supplier in the form of bio-energy. [9] Energy is used in every form of inputs such as human, seeds, fertilizers, pesticides, diesel fuel, electricity and machinery to perform various operations for crop production. Energy use in agriculture has increased in response to increasing populations, limited supply of arable land and desire for an increasing standard of living. In all societies, these factors have encouraged an increase in energy inputs to maximize yields, minimize labor-intensive practices, or both. [10]

2. Materials And Methods

The experiment was conducted at the research station of the Faculty of Agriculture and Natural Resources University of Khuzestan. A statistical Randomized design was applied, the treatments were including three different mushroom growing beds, wheat straw, palm fiber, bagasse, and three dietary supplements, soybean meal, canola meal, and poultry manure. Also beds without food dietary supplements were compared.

The energy equivalents were computed for all inputs and outputs using the conversion factors (obtained from previous studies) indicated in Table 1. Accordingly, the energy equivalents were calculated by multiplying the quantity all inputs used to produce mushroom.

Table1: Energy equivalents of inputs and output in mushroom production

Item	Unit	Energy equivalent (MJ unit^{-1})	Reference
Inputs			
Human labor	HR		[11]
Men		1.96	
Women		1.57	
Machinery	HR	62.7	[12]
Chemical biocides	Kg		
Fungicides		216	[13]
Plastic	Kg	45	[14
Water for irrigation	L	1.02	[15]
Electricity	Kw/H	11.93	[16]
	R		
Diesel fuel	L	56.31	[16]
Natural gas	M^3	49.5	[16]
poultry manure	HR	0.3	[17]
soybean meal	Kg	4.6	[18]
canola meal	Kg	18.7	[18]
Wheat straw	Kg	12.5	[19]
palm fiber	Kg	9.2	[20]
Bagasse	Kg	16.3	[21]
Wheat seed	Kg	25	[19]
Output	Kg		
Oyster mushroom		1.4	[22]
Compost		4.6	[23]

Energy equivalents used and indices

Mushroom culture is a cyclical process and involves several different operations, each of which must be carefully performed. During the crop cycle, mushrooms were harvested in a series of breaks or flushes that occur at approximately 7 or 8 day intervals with hand carefully. After two flushes, mushroom production declines rapidly so that each successive flush produces fewer mushrooms. The input resources of mushroom production were human labor, button mushroom compost, machinery and equipment, diesel fuel, chemicals, water for irrigation and electricity. Based on energy equivalent of inputs and output (Table 1), average, minimum and maximum amounts of energy inputs and output in oyster mushroom production were calculated as shown in Table 2. Using the value of energy inputs and output in mushroom production system, energy indices such as energy use efficiency (energy ratio), energy productivity, specific energy and net energy gained have been determine as followed equations. [24, 25, 26]

$$Energy\ Productivity = \frac{Mushroom\ yield\ kg\ m^{-2}}{Energy\ Input\ Mj\ m^{-2}} \quad (1)$$

$$Specific\ Energy = \frac{Energy\ Input\ (MJ\ m^{-2})}{Mushroom\ yield\ (kg\ m^{-2})} \quad (2)$$

$$Net\ Energy = \frac{Output\ Energy\ (Mj\ m^{-2})}{Input\ Energy\ (MJ\ m^{-2})} \quad (3)$$

The energy ratio gives an indication of how much energy was produced per unit of energy utilized. The energy productivity provides quantitative data on how much oyster mushroom is obtained per unit of input energy. Net energy is defined as the difference between the gross energy output produced and the total energy used for obtaining it (Mobtaker et al., 2010).

3. Results and Discussions

Prior to energy use pattern analysis of oyster mushroom production, energy use amount in compost production (among the most important inputs of oyster mushroom production) was estimated. Table 2 shows the inputs use and their energy use equivalent values. As the result of energy use pattern analysis, the amounts of energy inputs use, mushroom yield and their energy equivalents were determined. These results are presented in (Table 2).

Determining the energy input of each input

Table (2) per square meter of inputs used in the context of different cultures and their energy content is given. The oyster mushroom production, respectively of fuel (diesel, electricity, natural gas) by 94.64% of energy consumption, high consumption of most energy inputs. The button mushroom on the energy produced in Khorasan Razavi province has the most consumed fuel at a rate of 76.79% of the energy input. [27] Button mushroom compost in the production in mazandaran of energy and electricity were the largest input of energy. [28] In the study done on agricultural production in the most consumed fuel in many cases the consumer is given. [29] High fuel consumption of the reasons could be the lack of adequate isolation facilities and production of new technologies as well as the lack of adequate heating and cooling systems and boilers in the preparation process of composting noted. The fuel input, substrate input were (wheat straw, bagasse and palm fiber) with 13.20% machinery 6.77%, 5.34% and chemicals by 5.20%, the largest plastic energy consumer input. Taking the reasons mentioned above inputs can be tested because the main part of the manufacturing process platform was noted. In the transport field, particularly bagasse bed because beds are far from centers that provide these inputs such as bagasse agro industry is the high percentage, chemical contamination of edible mushrooms due to high sensitivity allocated more and energy inputs due to the plastic bag was oyster mushroom cultivation is justifiable that a greater percentage of energy input. Will be long inputs in order to rate Supplements Plastics, seed, human Supplements and water 2.94, 1.02, 0.51 and 0.03 percent, respectively (Figure 1).

In the study conducted by [30] in green house products of Tehran province, total energy input use was calculated to be 1.57 MJ for each kilogram of cucumber. They also reported fuel (for heating the greenhouses) and animal manure as the high energy consuming inputs in cucumber production. Moreover, (Banaeian et al., 2011). investigated energy use pattern in 25 green houses of strawberry production in Tehran province, Iran. In our study, results indicated that a total energy of 121891.33 MJ·ha^{-1} (about 2 MJ·ton^{-1}) was used in greenhouse units. Diesel fuel (78%), chemical fertilizers (10%) and electricity (4.5%) were the highest energy consuming inputs. On the contrary, water for irrigation contribution was relatively low (0.47%). This is mainly due to lower water need of mushroom in contrast with other products.

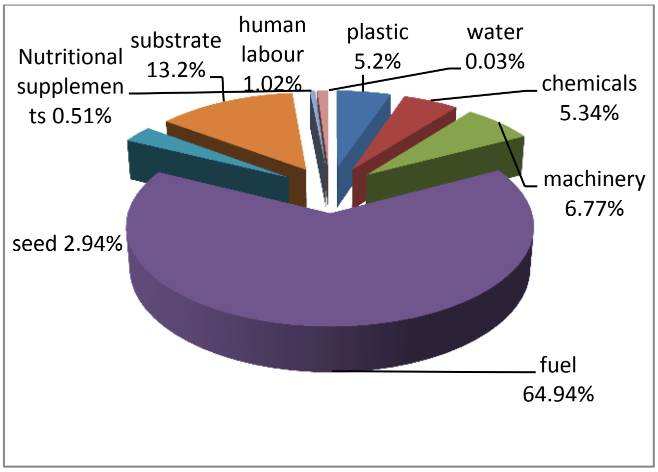

Figure1: The share of the input energy in the production of oyster mushrooms in a period of production

The energy input and output of different substrates for oyster mushrooms

The results of incoming and outgoing energy was given in different substrates (wheat straw, palm fiber, bagasse) in the table (3).

Results indicate that the amount of input energy for wheat straw, palm fiber and bagasse were 205.95, 176.29 and 454.04 MJm^{-2} respectively. Input energy of Palm fiber was less than the other beds. This result was due to the shorter duration of palm fiber bed compared to other media. The differences between the power factor input of human resources in the context of bagasse was the highest amount included of 4.3. The platform was based on the amount of input energy from bagasse 36.75 MJm^{-2} and Palm fiber bed was the lowest rate 31.49 MJm^{-2}. The maximum amount of diesel fuel was at a rate of 225.20 MJm^{-2} of bagasse substrate and in the context of palm fiber and wheat straw was 4.6 and 2.2 MJm^{-2} respectively. Most of the amount of electricity in the context of energy consumption in order to bagasse bed, wheat straw and palm fiber was concerned of 0.40, 0.39 and 0.35 MJm^{-2} were respective. Input energy of natural gas used for pasteurization wheat straw, bagasse and palm fiber at a rate of 121.6, 106.4 and 89.6 MJm^{-2} for respective. Total input energy efficiency was calculated for the production of oyster mushrooms was shown 1902.70 Mjm^{-2}. The amount of input energy in the production of button mushrooms in Khorasan Razavi reported efficiency province 24808.60 GJha^{-1} (saeedi et al, 2014). This is represents less input energy per unit area for the oyster mushroom than button mushroom.

Table2: The amount of energy input and output for oyster mushroom production in different substrates for one period of production (Mjm^{-2})

Substrate	Wheat straw	Palm fiber	Bagasse	average weight	Percentage
Input					
Water	0.16	0.08	0.07	0.10	0.03
Human Labor	2.5[c]	2.8[b]	3.4[a]		
Nutritional Supplements	1.45	1.45	1.45	1.45	0.51
Poultry Manure	0.01	0.01	0.01	0.01	
Soybean meal	0.28	0.28	0.28	0.28	
Canola meal	1.16	1.16	1.16	1.16	
Substrate	31.88[b]	31.49[c]	36.75[a]	37.33	13.20
Seed	8.33	8.33	8.33	8.33	2.94
Fuel	124.29	94.55	332	183.61	64.94
Electricity	0.39[a]	0.35[a]	0.40[b]	0.38	
Diesel fuel	2.3[c]	4.6[b]	225.2[a]	77.36	
Natural gas	121.6[a]	89.6[c]	106.4[b]	105.86	
Machinery	7.32[c]	8.36[b]	41.80[a]	19.16	6.77
Plastic	14.72	14.72	14.72	14.72	5.20
Chemical Biocides	15.30[b]	14.51[b]	15.52[a]	15.11	5.34
Input total energy	205.95	176.29	454.04	282.71	100

The common letter(s) in a column did not differ at the level of 5% probability as per LSD

The analysis of variance interaction substrate and supplement for electricity, chemicals and substrate of oyster mushroom indicated significant differences among the various substrate pretreatment methods (table 2) There was a significant (P<0.01). The amounted of electric energy.

Electricity Energy

The maximum of electricity energy in bagasse bed combined with Poultry manure, bagasse and wheat straw bed without combination food supplements were shown 45.0, 42.0 and 42.0 belonged MJm^{-2} (Figure 2) and the lowest rates of palm fiber bed without combination food supplement, palm fiber combined with poultry manure and canola meal respectively 33.0, 35.0 and 35.0 MJm^{-2}. The differences energy consumption due to the input materials for growth period was shown in figure 3.

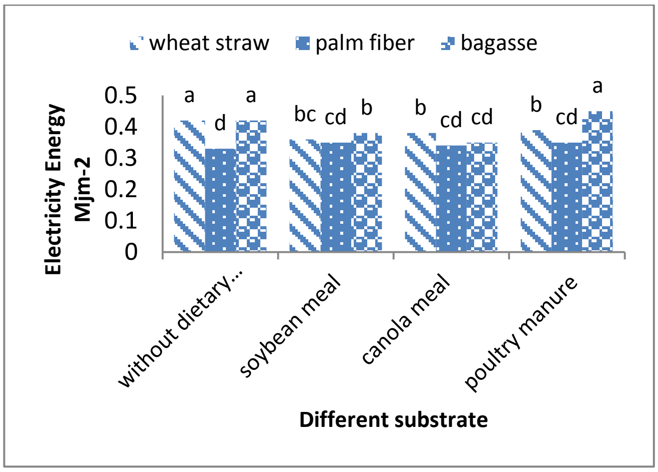

Figure2: Electricity consumption in the context of oyster mushroom cultivation. The common letter(s) in a column did not differ at the level of 5% probability as per LSD

Substrate Energy

Figure (3) indicates that the greatest amount of input energy for bagasse bed combination with soybean meal and canola meal were shown 38.07 and 37.72 MJm^{-2} and the lowest was palm fiber supplemented with poultry manure at a rate of 29.82 MJm^{-2} (Figure 3). The reason, more weight in the bed than other platforms due to its high density and also because of high energy equivalent to other substrates increased bagasse based energy.

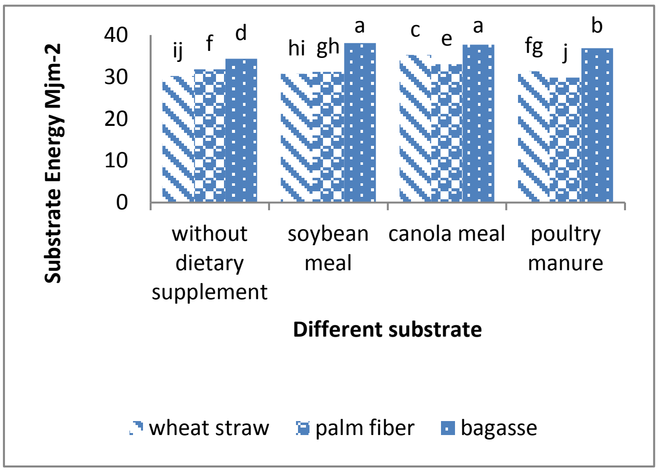

Figure3: Substrate consumption in the context of oyster mushroom cultivation. The common letter(s) in a column did not differ at the level of 5% probability as per LSD

Chemicals Energy

The maximum amount of input energy for chemical were shown in bagasse bed with supplement poultry manure and wheat straw without supplement 16.31, 15.92 and 15.83 MJm^{-2} respectively and the lowest amount was come up palm fiber bed without food supplement 14.31 MJm^{-2}, (Figure 4).

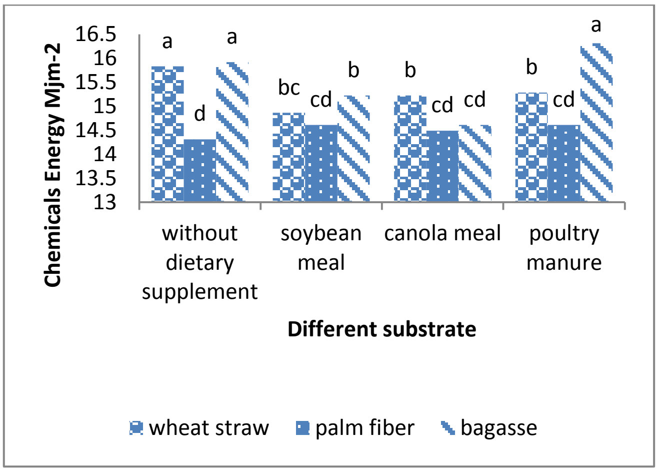

Figure4: Chemical consumption in the context of oyster mushroom cultivation. The common letter(s) in a column did not differ at the level of 5% probability as per LSD

The analysis of variance for natural gas, machinery, fuel and labor for oyster mushroom production indicated significant differences (P<0.01) among the various substrate pretreatment methods (Table 2).

Most of the natural gas based energy platform was 121.6, 106.4 and 89.6 MJm^{-2} wheat straw, bagasse and palm fiber respectively (Figure 5). Machines energy inputs were related to the context of bagasse, palm fiber and wheat straw at 41.80, 8.36 and 7.32 MJ/m^2 (Figure 6). Fuel energy input for bagasse, palm fiber and wheat straw at a rate of 225.2, 4.6 and 2.3 MJm^{-2} (Figure 8). The amount input energy for manpower was to bagasse, palm fiber and wheat straw respectively 3.4, 2.89 and 2.58 MJm^{-2} (Figure 7).

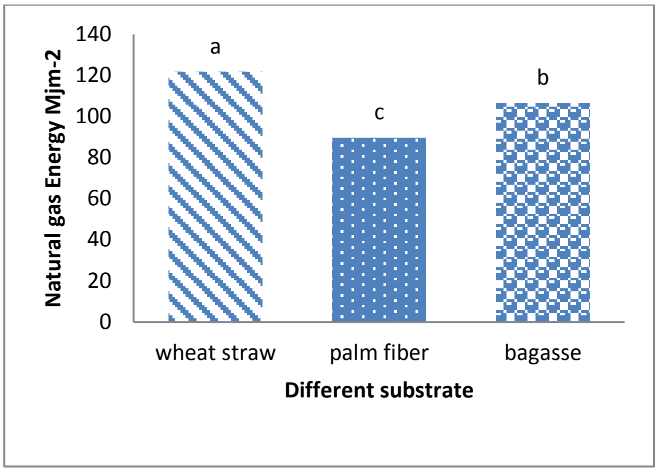

Figure5: Natural gas consumption in the context of oyster mushroom cultivation. The common letter(s) in a column did not differ at the level of 5% probability as per LSD

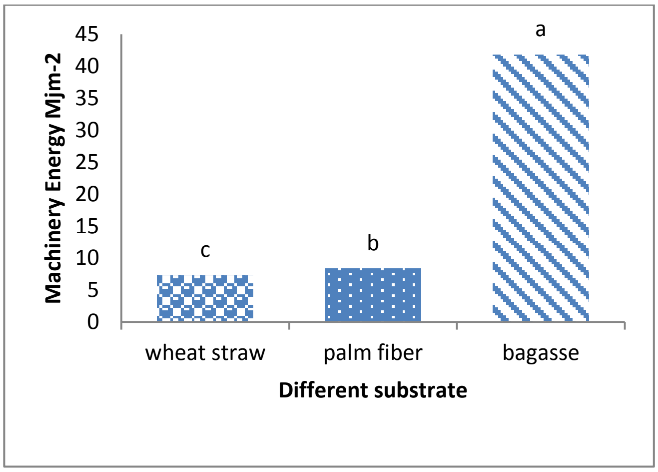

Figure6: Machinery consumption in the context of oyster mushroom cultivation. The common letter(s) in a column did not differ at the level of 5% probability as per LSD

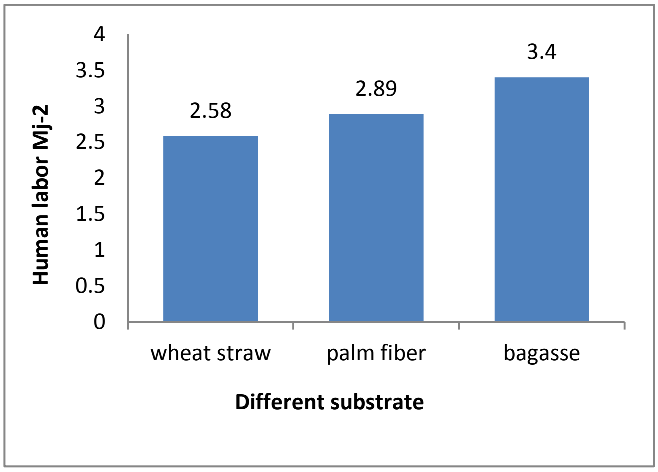

Figure7. Human labor consumption in the context of oyster mushroom cultivation. The common letter(s) in a

column did not differ at the level of 5% probability as per LSD

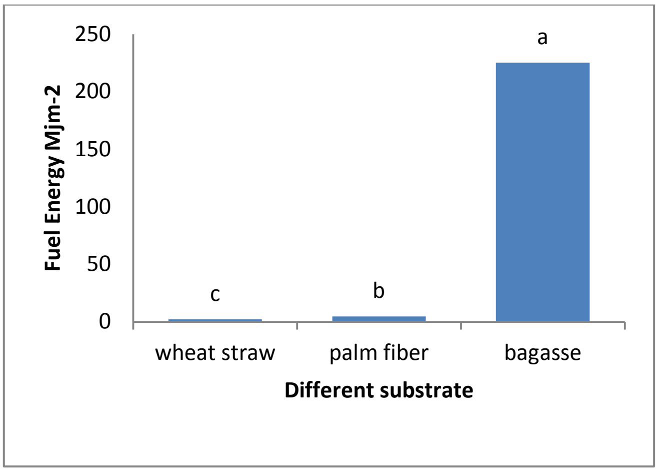

Figure8: Fuel consumption in the context of oyster mushroom cultivation. The common letter(s) in a column did not differ at the level of 5% probability as per LSD

Since the remainder production of oyster mushroom compost was as a source of energy in the study along with the product oyster mushrooms calculated as output energy. Oyster mushroom compost was production with the remaining energy index in the cultivation of various substrates in the table (3) and (4).

Specific Energy

The analysis of variance effect substrate and Nutritional supplements for Energy efficiency of oyster mushroom indicated significant differences among the various substrate pretreatment methods (table 3) There was a significant ($P<0.01$).

Most energy efficiency was in the context of palm fiber, wheat straw and bagasse of 0.33, 0.25 and 0.13 MJm^{-2} (Figure 9)

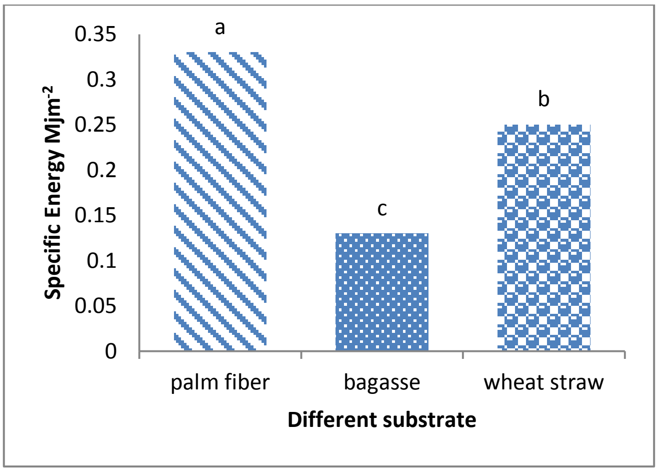

Figure9: The effect of substrates on Specific Energy. The common letter(s) in a column did not differ at the level of 5% probability as per LSD

Highest energy efficiency belonged in order to complement poultry manure, rapeseed meal, soybean meal and without combination with a food supplement and the value of 0.247, 0.244, 0.238 and 0.236 MJm^{-2} (Figure 10)

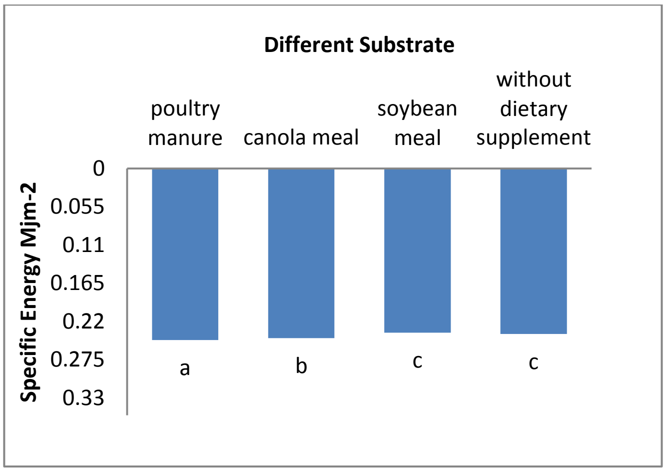

Figure10: The effect of food supplements on Specific Energy. The common letter(s) in a column did not differ at the level of 5% probability as per LSD

Energy efficiency of button mushroom compost was reported in Khorasan Razavi Province 0.164 (saeedi et al, 2014). Other studies reported in the province 0.20 energy efficiency. [31]

In this study of efficiency energy for oyster mushroom and compost was more than obtained in studies conducted on the button mushroom and compared to other products was less greenhouse efficiency energy. This requires more attention to the product and training of workers and managers with modern principles of mushrooms and production of measures to manage the energy consumption per unit.

Energy Productivity

The analysis of variance Interaction substrate and Supplement Energy efficiency of oyster mushroom indicated significant differences among the various substrate pretreatment methods (table 3) There was a significant ($P<0.05$).

The highest efficiency of oyster mushrooms as a palm fiber combination with poultry manure and canola meal were shown 0.099 and 0.097 $kgMj^{-1}$ and the lowest energy productivity in the bagasse bed without combination with dietary supplement and bagasse bed with soybean meal were shown 0.031 and 0.032 $kgMj^{-1}$.

Net Energy

The analysis of variance effect substrate and Nutritional supplements for Net Energy of oyster mushroom indicated significant differences among the various substrate pretreatment methods (Table 3) There was a significant ($P<0.01$).

The greatest amount of energy added to substrates such as bagasse, wheat straw and palm fiber to the -393.19, and -116.86 -153.79 Mjm^{-2} (Figure 11) and increased the maximum amount were assessed of energy in food supplements in order to supplement rapeseed meal, soybean meal, poultry manure without combination with complementary and supplementary to the -224.19, -222.17, --218.39 and -220.36 MJm^{-2} (Figure 12).

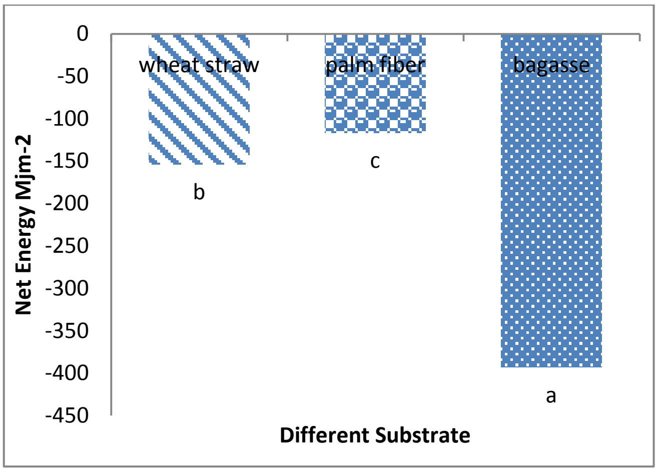

Figure11: The effect of substrates on Net Energy. The common letter(s) in a column did not differ at the level of 5% probability as per LSD

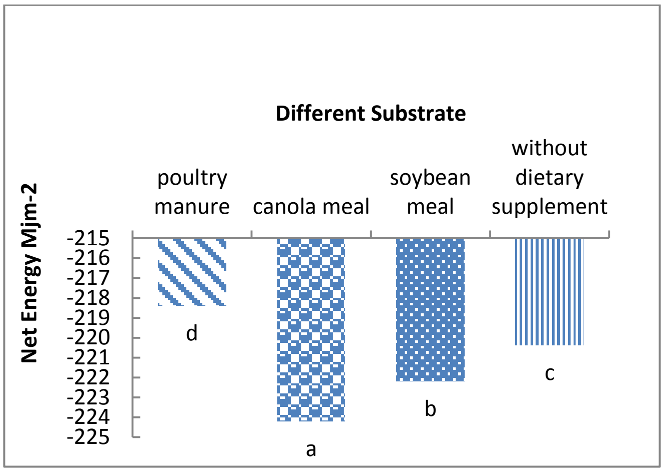

Figure12: The 0effect of food supplements on Net Energy. The common letter(s) in a column did not differ at the level of 5% probability as per LSD

Which indicated that the amount of energy output was less than the amount of input energy in the production of oyster mushrooms. Oyster mushroom production of energy in the context of palm fiber is more affordable. In most agricultural products have been added to the positive energy. [32] Some products have been added to the negative energy. [33]

Table3: Analysis of variance of substrate and food supplements on energy indices

mean of squares Sources changes	Degrees of freedom	Input energy	Net Energy	Specific Energy;	Energy Productivity
Substrate	2	279207.94**	270083.01**	0.125**	0.011**
Nutritional supplements	3	99.09**	55.45**	0.0002**	0.0001**
Substrate* Nutritional supplements	6	1.30**	2.04^{ns}	0.00002^{ns}	0.00001*
Error	24	0.29	1.45	0.0001	0.000005
Cv		0.21	0.54	1.60	3.65

Table4: Comparison of interaction between the substrate and complementary energy index

Mean Specifications	substrate	Poultry manure	Canola meal	Soybean meal	Without dietary supplement
Energy Productivity	Wet straw	0.073[c]	0.075[c]	0.060[e]	0.065[d]
	Palm fiber	0.099[a]	0.097[a]	0.091[b]	0.093[b]
	bagasse	0.037[f]	0.037[f]	0.032[g]	0.031[g]
Input energy	Wet straw	203.95[f]	212.59[e]	203.99[f]	203.55[f]
	Palm fiber	173.43[i]	181.15[g]	175.93[h]	168.09[i]
	bagasse	453.69[c]	457.37[a]	454.83[b]	450.74[d]

The common letter(s) in a column did not differ at the level of 5% probability as per LSD

4. Conclusions

Fossil fuels (64.94 MJm^{-2}), substrate (13.2 MJm^{-2}) and machinery (6.77 MJm^{-2}) were mostly contributed inputs to energy consumption. As a result of this study, effectiveness of use of all inputs can be achieved in an informed and efficient production system. In this regard, extension programs toward the development of such systems should be taken into consideration.

Results indicated that the amount of input energy for wheat straw, palm fiber and bagasse was 205.95, 176.29 and 454.04 ($MJm^{-2)}$ respectively. Palm fiber input energy was less than the other substrate. This result is due to the shorter duration of palm fiber bed compared to other substrates.

The greatest amount of energy added to substrates such as bagasse, wheat straw and palm fiber was -393.19, -116.86 and -153.79. The maximum amount was assessed order to supplement rapeseed meal, soybean meal, poultry manure as calculated by -224.19, -222.17, -218.39 and -220.36 (MJm^{-2}).

References

[1] B. Alice, K . Michael, "Mushroom Cultivation and Marketing" .NCAT ATTRA Publication, N0 IP087, 2004.

[2] F. R. Hassan, G. M. Medany and S. D. Hussein, "Culivation of the king oyster mushroom *(Pleurotus eryngii)* in Egypt," *Australian Journal of Basic and Applied Sciences*, 4(1), pp 99-105, 2010.

[3] H. M. N. Iqbal, M. Asgher, and H. N. Bhatti," Optimization of physical and nutritional factors for synthesis of lignin degrading enzymes by a novel strain of Trametes versicolor," BioResources, (6), 1273-1278, 2011.

[4] Anonymous, "Iran Annual Agricultural Statistics," Ministry of Jihad-e-Agriculture of Iran. [Online]. Available: [Accessed: 2008].

[6] P. B. Flegg, D. M. Spenser, D. A. Wood, "*The biology and technology of the cultivated mushroom,"* Oxford, Oxford Press, 1985.

[7] S, Chang. "Overview of mushroom cultivation and utilization as functional foods," In P. C. Cheung (Ed.), *Mushrooms as Functional Foods*, New Jersey: John Wiley & Sons, Inc. pp. 1-33, 2008.

[8] P. Stamets, "Cultivation of Morels mushroom," J. Wild Mushrooming, 11(41), 9-15, 1993.

[9] M. S. Alam, M. R. Alam, and K. K. Islam,"Energy Flow in Agriculture: Bangladesh" *Am. J. Environ. Sci.*, 1(3), pp. 213–220, 2005.

[10] K. Esengun, O. Gunduz, and G. Erdal, "Input–output Energy Analysis in Dry Apricot Production of Turkey," *Energy Convers. Manage*., 48: 592–598, 2007.

[11] S.Singh, J. P. Mittal, C. J. S. Pannu, and B.S. Bhangoo, "*Energy inputs and crop yield relationships for rice in Punjab*," Energy (19), 1061-1065, 1994.

[12] S. Singh and J. P. Mittal, "*Energy in Production Agriculture*," Mittal Publications., and J. P. Mittal. 1992.

[13] S.Rafiee, SH. Mousavi Avval, and A. Mohammadi, "*Modeling and sensitivity analysis of energy inputs for apple production in Iran*," Energy (35), PP 3301-3306, 2012.

[14] Walters R. N., S. M. Hackett, and R. E. Lyon, " *Heats of Combustion of High Temperature Polymers*," Fire and Materials (24), PP 245-252, 2000.

[15] B. Ozkan, C. Fert, and C. F. Karadeniz, " *Energy and cost analysis for greenhouse and open-field grape Production*," Energy (32), PP 1500-1504, 2007.

[16] H. G. Mobtaker, A. Keyhani, A .Mohammadi, S .Rafiee, A . Akram. "Sensitivity analysis of energy inputs for barley production in Hamedan province of Iran," Agric Eco syst Environ. (137), pp 367-72, 2010.

[17] SH. Pishgar Komleh, M. Omid, and M. D. Heidari, "*On the study of energy use and GHG(greenhouse gas)*

emissions in greenhouse cucumber production in Yazd province," Energy (59), PP 63-71, 2013.

[18] Hill, R.C.; C.F. Burrows; J.E. Bauer; G.W. Ellison; M.D. Finke; G.L. Jones. Texturized vegetable protein containing indigestible soy carbohydrate affects blood insulin concentrations in dogs fed high fat diets. *J. Nutr.* **2006,** *Vol. 136,* 2024S–2027S.

[19] B. Ozkan, H. Akcaoz, and C. Fert, " *Energy input–output analysis in Turkish agriculture*," Renewable Energy (29), PP 39-51, 2004.

[20] O. Abu Hassan, M. Ishida, I. Mohd Shukri, Z. Ahmad Tajuddin, "Oil Palm Fronds as a Roughage Feed Source for Ruminants in Malaysia," accessed (20), pp 12.11, 2001.

[21] R. Singh, AJ. Verma, RS. Laxman, and M. Rao, "Hydrolysis of cellulose derived from steam exploded bagasse by penicilium cellulases," comparition with commercial cellulose, Bioresour Technol, (100), 6679-6681, 2009.

[22] p. Mattila, H. Aro, and T. Jalva, "Basic composition and amino acid contents of mushrooms cultivated in Finland," JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY, (50), pp 6419-6422, 2002.

[23] S. McCahey, J. T. McMullan, and B. C. Williams. "*Consideration of Spent Mushroom Compost as a Source of Energy*," Developments in Chemical Engineering and Mineral Processing, (11), 43-53, 2003.

[24] M. D. Heidari and M. Omid. "*Energy use patterns and econometric models of major greenhouse vegetable productions in Iran*," Energy, (36) pp 220-225,2011.

[25] , K. G.MandalSaha, K. P., Ghosh, P. K. Hati, and K. M. Bandyopadhyay, "Bioenergy and Economic Analysis of Soybean-based Crop Production Systems in Central India," *Biomass Bioenergy*, 23(5), pp 337–345, 2002.

[26] A. Mohammadi, A. Tabatabaeefar, S. Shahin, S. Rafiee, A.Keyhani," Energy use and economical analysis of potato production in Iran," a case study: Ardabil province, Energy Conversion and Management, 49(12), 3566-3570, 2008.

[27] M. Saeedi, M. Khojastehpour, M. Hossein Abasspour-Fard, M. Farsi, and A. Nikkhah, " Investigation of Energy Consumption for Button Mushroom Production (*Agaricus Bisporus*) under Different Annual Growing Area in Khorasan Razavi Province," Journal of Agricalture of Mecanization in Khorasan Razavi,1 (2), pp 58-66, 2014.

[28] P. Qasemi Kordkheili, N . Kazemi, A. Hemmati, M. Taki." Energy input-output and economic analysis of soybean production in Mazandaran province of Iran," Elixir Agriculture (56), 13246-51, 2013.

[29] N. Banaeian, M. Omid and H. Ahmadi, “Energy and Eco- nomic Analysis of Greenhouse Strawberry Production in Tehran Province of Iran,” *Energy Conversion and Man-agement,* Vol. 52, No. 2, pp. 1020-1025, 2011.

[30] F. Ghojebeig, “A Decision Support System for Optimiz- ing Energy Consumption in Vegetable Production Green- houses,” M.S. Thesis, University of Tehran, Karaj, 2010.

[31] H. Reyhani-Farashah, A. Hemmati, A. Tabatabaeefar, and A. Rajabipour, "*Optimization of energy consumption and cost saving for button mushroom production in Alborz province of Iran*," International Journal of Agriculture and Crop Sciences, 5 (12), 1297-1306, 2013.

[32] A. Mohammadi, S. Rafiee and S. Mohtasebi and H. Ra- fiee, “Energy Inputs Yield Relationship and Cost Analysis of Kiwifruit Production in Iran,” *Renewable Energy*, Vol. 35 No. 5, pp. 1071-1075, 2010.

[33] S. M. H, S. Tabatabaie, s. Rafiee,A. Keyhani, and M. D. Heidari, "*Energy use patte rn and sensitivity analysis of energy inputs and input costs for pear production in Iran*," Renewable Energy (51), pp 7-12, 2013.