RICE STRAW RECYCLING FOR DEVELOPING THE HYDROPONICS SPROUTED BARLEY PRODUCTION AND CONSERVING THE ENVIRONMENT

Khaled K. Hegab*

ABSTRACT

Open-field burning of the rice straw is clearly practiced and considered a significant source of air pollutants. Increasing the quantity and conserving the quality of the hydroponics sprouted barley are considered critical issue for feeding the large animals and executing food security. Therefore, the main objective of this research is to deter mine the best method for recycling of the rice straw as "a bio-media" and increasing the quantity and conserving the quality of the hydroponics sprouted barley. Randomize complete block design experiment was executed through (27) treatments. Three classes of rice straw m "rough media (less than 7.5cm), medium media (less than 5cm), and fine media (less than 2.5cm); three ratios between rice straw weigh to dry grains weight "25, 50, and 75" (%); and three periods of growth life durations "8, 10, and 12 days" were applied. Statistical analysis processes of the results revealed that using medium media of rice straw (less than 5cm), with ratio of 50%, and periods of 10 days is considered the beast treatment.

Keywords: *Rice straw recycling - hydroponics sprouted barley production - conserving the natural environment.*

INTRRODUCTION

It is difficult to execute food security of meat and milk with absent of the big animals "Cows and Buffaloes"; to meet the daily need of the hydroponics sprouted green barley for feeding the big animals "25-50 kg per head"; and to meet the needed facilities for managing and recycling the annual production of rice straw which is burned inside the field producing hazard gases causing environmental pollution. Therefore the main problem is the lack of the needed fresh feeds for feeding the big animals. In Addition to this problem, the environmental pollution is consciously occurred due to the rice straw open-field burning.

***Agric. Eng. Dept., Faculty of Agriculture, Cairo University, Egypt.**

The global production of agricultural residues from six crops “barley, maize, rice, soybean, sugar cane and wheat” in 227 countries and territories of the world is $3.7^{+1.3}_{-1.0}$ Pg dry matter yr^{-1}. North and South America, Eastern, South-Eastern and Southern Asia and Eastern Europe each produce more than 200 Tg yr^{-1}, **Bentsena et al. 2014**. Generally, these residues could be managed and recycled in traditional management methods to produce useful materials friendly to the environment such as; (1) biogas production by anaerobic digestion **Sheetsa et al. 2015, Poulsena and Adelardb 2016, Elaiyaraju and Partha 2016;** (2) soil properties improvement **Roa et al. 2014**, **Medinaa et al. 2015, Yu et al. 2016**; (3) compost production and improvement **Gutiérreza, et al 2016, Nigussiea et al. 2015, Gavilanes-Terána et al. 2016;** bio-ethanol production **Belloa et al. 2014**, **Gabhanea et al. 2014;** (4) celluloses production **Bansala et al. 2012**; (5) biochemical production **Alavijeha and Yaghmaeia, 2016**, (6) celluloses and paper production **Fahmy et al. 2017**; (7) bio-based composites production **Ashoria and Nourbakhshb 2010**; and (8) animal feeds production **Chena et al. 2015**. Also, these residues could be managed and recycled in unconventional methods to produce: additives for reinforcements such as: (1) Natural fiber-polymer composites (NFPCs) **Väisänena et al. 2016**; and (2) clay matrix bricks, **Barbieri et al. 2013**.

In Egypt, there are about 30 million tons of agricultural residues available per year. Due to limitation of the needed facilities to manage these residues in Egypt a great percentages of these residues are randomly burned inside the cereal farms producing hazard gases constituting environmental pollution, **FAO 2006, EEAA, 2008, and Hanafi et al. 2012**. Cereal crops generate large amount of agricultural residues in many countries. Area harvested, rice production, and straw production in the world are 158,511 per1000 ha, 684,595 kton of Rice/a, and 727,400 kton of straw/a respectively, **Boschma and Kwant, 2013.** Briefly, these residues are used mainly in feeding and bedding processes.

Rice straw open-field burning is practiced in many countries and has been proven to be a significant source of air pollutants, which can cause serious effects on the ambient air quality, public health and climate, **Moussa and Abdelkhalek 2007, Tipayarom and Oanh 2007, Ks et al.**

2008, Gaddea et al. 2009, Kanokkanjana et al. 2011, Liu et al. 2011, Maninder et al. 2012, Chang et al. 2013, Farag et al. 2013, Kanokkanjana and Garivait 2013, Nakhla et al. 2013 and Nageh et al. 2015.

Rice straw could be managed and recycled in traditional and unconventional methods to produce useful materials friendly to the environment such as: (1) biogas production **Yea et al. 2013, Zhou, et al. 2015**; (1) co-composting **Ishii, and Furuichi, 2014; (3)** pelleting **Qiana et al. 2014**; and (4) paper making **Kaura, et al. 2016**.

Disposal of rice straw by open burning is unacceptable due to accelerating losses of soil organic matter and nutrients, increasing C emissions, causing intense air pollution, and reducing soil microbial activity, **Ebid et al., 2008, Kumar and Goh 2000**. Approximately 80% of the rice straw in the world is growing by small scale farms in the developing, including South East Asia. The large amount of rice straw “as by product of the rice production” is mainly used as a source of feed for ruminant livestock, **Sarnklong et al. 2010.** Estimated emissions of greenhouse gases and other air pollutants as a result of field burning of rice straw in Egypt are: 9344.0, 4.7, 5.1, 463.4, 22.5, 0.9, and 82.9 of CO2, CH4, N2O, CO, NOx, SOx, and $PM_{2.5}$ respectively, **Bakker et al. 2013**. The excess air is a very important for minimizing the greenhouse gases emission and maximizing the combustion temperature. Therefore, the open burning is producing huge amounts of the greenhouse gases polluting the environment, **Bradna and Malaťák 2016**.

Rice straw has low quality feedstock primarily determined by a high ash content (10-17%), high silica content in ash (SO2 is 76%), and low total alkali content (Na_2O and K_2O) < 15% of total ash, **Kargbo et al. 2010.** Nutrient content of rice straw covering dry matter DM, organic matter OM, Fat, crude protean CP, acid detergent insoluble CP “ADICP”, neutral detergent fiber NDF, digestible NDF “dNDF”, acid detergent fiber ADF and total detergent nutrients TDN are 93.93%, 83.59, 1.94, 4.81, 12.60, 67.57, 38.33, 49.49, and 40.90% of DM respectively. Also, the chemical elements of rice straw covering Calcium Ca, Phosphorus P, Magnesium Mg, Potassium k, Sulfur S, Sodium Na, Chlorine Cl, Cupper Cu, Iron Fe, Zink Zn, and Molybdenum Mo, are “0.30, 0.09, 0.19, 1.74, 0.06, 0.15, 0.52 %", "4.3, 356, 28, 0.84 ppm DM" respectively, **Nader and Robinson, 2010.** In a chemical analysis process for rice straw **Ghoneim, 2008** found that the total C (gg^{-1} DW), the total N (gg^{-1} DW), and C/N ratio are 0.366, 0.008, and 45.2 respectively.

Physical, chemical, and biological treatments are applied on the rice straw to enhancement its nutritive value. Physical treatment such as crushing is related to breaching the silicified encrusting layer of straws. Chemical treatment is applied by using alkalis such as ammonium and sodium hydroxide for improving both apparent digestibility, bacterial colonization on cellulose and voluntary intake of straw, **Sarnklong et al. 2010, and Hanafi et al. 2012,** Ruminate animals in many tropical countries subsist mainly on crop residue "such as wheat, barley, and rice straw" based diets. These residues are rich with cellulose bounded with lignin. Rumen bacteria, protozoa, and fungi are not very strong enough to break the lingo-cellulose. Therefore, biological treatment using white rot fungi is applied to break the lingo-cellulose for enhancing feeding value, increasing digestibility, and decreasing methane emission, **Mahesh and Mohini, 2013**. **Abd El Rahman et al. 2014,** concluded that applying biological treated straw in growing calves ration is effective way for improving nutrients digestibility, body weight gain and economic efficiency. **Akinfemi and Ogunwole, 2012,** concluded that treatment of rice straw with different edible mushrooms improve the potential feeding value of the resultant substrate. Therefore the production of fungal treatment has a good potential as feed resources for ruminants.

Physical treatment of rice straw could be done using the stationary thresher machine (at feeding rate 1.5 ton/h) in cutting length percentage 82.1 % less than 3.5 cm with power consumption, energy requirement, and operating cost are (43.4 kW), (38.7 kW.h/ton), and (25 LE/h) respectively, **Arafa, 2007**. For continues flow of straw to a fluidized bed gasification, a straw chopping system was designed with technical specification of "feed rate, power consumption, and straw length are (1.48-1.10.52 kg/min), (1.76-7.76 hp), and (14.49-18.85 mm) respectively, **Ghaly, et al. 2013**. **El Dahshan and Bejo 2009,** found that the performance of the hummer mill was in optimum region at hummer drum speed of 44.2 m/s, concave whole diameter of 2mm, and rice straw moisture content3.4%.

MATERIALS AND METHODS

2.1-Rice straw media preparation:

Rice straw pales with dimensions of 50, 40, and 100 cm were purchased from the local market in Egypt. These pales are produced by using modified stationary thresher machines through chopping the rice straw hay with desired cutting lengths. According to **Arfa 2007, Tarek et al. 2007,** these machines are successfully used for chopping rice straw hay through concave slots area of $4cm^2$, drum speeds of 18.33 m/s, feeding rates of 1.5 ton/h, moisture content of 14.3 % and concave clearance of 3 cm resulting in cutting length percentage of 82.1 % less than 3.5 cm. Power consumption and energy requirement were (43.4, kW) and (28.9 kW.h/ ton). For rice straw media preparation, three screens were used to produce three piles of rice straw. The first containing rice straw with length is less than 2.5 cm, the second containing rice straw with length is less than 5 cm, the third containing rice straw with length is less than 7.5 cm length.

2.2- Trails design:

To minimize the total number of the all treatments, the sprouted barley production without rice straw media treatments was neglected. Also, the difference between the sprouted barley production fresh weight with and without using rice straw media is great. Briefly, factorial experiment in complete randomize design containing 27 treatments of hydroponics sprouted barley on rice straw media was applied, table (1), **Landau and Everih 2004, Toutenburg and Shalabh 2009**. Three durations “treatments” of growth life were used the first, the second, and the third are 8, 10, 12 days respectively. Three ratios “treatments” of “rice straw weigh to dry grains weight" for each growth life duration were applied. The first ration is 25%, the second ratio is 50%, and the third ratio is 75%. Three levels of the physical dimensions “treatments” of the utilized rice straw pieces were applied. The first is rough straw with length is equal to or less than 7.5 cm, the second is medium straw with length is equal to or less than 5 cm, and the third is fine straw with length is equal to or less than 2.5 cm. The poorest treatment T_1 which containing "long straw, little weight of straw, and short duration life" was used as control in the in the statistical analysis processes.

2.3- Experiments management:

Hydroponics green fodder chamber with dimensions of 4, 6, 3m for wide, length, and high respectively was locally designed and fabricated. This chamber contains three stands with production capacity of (144) tray per each stand. The three stands were designed with the same dimensions and the same vertical distance between rows of trays "30 cm" to keep enough space for vegetation growth. The trays were made of fiberglass with dimensions of "30x90x5 cm". Three production cycles were executed for production of hydroponics sprouted barley on rice straw media inside the chambers. Steiner Nutrients Solution was added to the sprouts through the irrigation system with concentration of 1000-2000 ppm in exception of the first and the last two days, **Steiner 1984**. Automatic ventilation, lightening, cooling systems were fixed to: refresh $_{1/4}$ of the sprouting champ's air every 3 hours, lightening the chamber with "2000 Lux" through 12 hours per day, and fix air temperature at 20 C^o through 75 to 85% relative humidity. Five hundred grams of dray Barley grains were used per each tray. Irrigation scheduled were fixed at 60 sec/ per 6 hours the first 4 days, 45 sec/ per 6 hours the second 4 days , and 30 sec/ per 6 hours the third 4 days of the growth life respectively. The dry grains were washed, socked, and composted through 1, 5, and 18 hours respectively.

2.4- Measurement and analysis operations:

Root layer thickness RLT "cm", vegetation growth high VGH "cm", fresh weight FW, dry matter percentage DMP %, DMW dry matter weight "g", ash percentage "Ash" %, crude protein percentage Cp %, crude fiber %, ether extract percentage EE %, and nitrogen free ether percentage NFE %, were determined in each replicate. The means of the RLT, VGH, FW, DMP, DMW, Ash, Cp, Cf, EE, and NFE were statistically analyzed as Arc SIN data. Chemical and nutrition analysis laboratories located in "Faculty of Agriculture, College of Veterinarian Medicine at Cairo University, and the Agriculture Research Center, Egyptian Ministry of Agriculture were used. All measurements were started after six hours of the production delivering moment outside the chamber. Briefly, the collected data were statistically analyzed as factorial experiments in complete randomizes “27 treatments with five replicates per each” using SPSS program, **Landau and Everitt 2004**. The whole trails were replicated three times.

Table (1): Trails design for investigating hydroponics sprouted barley production on rice straw media:

Growth life duration (day)	Ratio between rice straw weigh to dry grains weight (%)	Physical dimensions of the rice straw pieces in the utilized media (cm)		
		Rough (85% less than 7.5cm)	Medium (85%less than 5cm)	Fine (85%less than 2.5cm)
8	25	T_1	T_2	T_3
	50	T_4	T_5	T_6
	75	T_7	T_8	T_9
10	25	T_{10}	T_{11}	T_{12}
	50	T_{13}	T_{14}	T_{15}
	75	T_{16}	T_{17}	T_{18}
12	25	T_{19}	T_{20}	T_{21}
	50	T_{22}	T_{23}	T_{24}
	75	T_{25}	T_{26}	T_{27}

Note: Five hundred grams of Barley grains were used per each tray. Steiner’s nutrients solution with concentration of 2000 ppm was used. Light intensity, air temperature and air relative humidity were automatically fixed inside the utilized hydroponics green fodder chamber within 1900-2000 Lux, 20-22C^0 and 75-85% respectively. Irrigation scheduled were fixed at 60, 45, and 30 second per 6 hours through the first 4 days, the second 4 days, and the third 4 days of the growth life duration respectively. T_1 is the control for comparing process.

RESULTS AND DISCUSSIONS

3.1. Effects of using rice straw media on quantity of the barley production:

Table (2) shows that the means of the root layer thickness are increased continuously due to the increase in the growth life duration. As a result, the significant increase is found through the 12 days growth life duration at "T_{25}". Also, this Table shows that the means of the vegetation growth high are increased continuously due to the increase in the growth life duration. As a result, the significant increase is found through the 12 days growth life duration at "T_{24} and T_{27}". Scientifically, the increase in the RLT was occurred to meet the plans need of water and nutrients. The increase in the VGH was occurred to meet the plans need of O_2, Co_2, and light. Also, since the fresh weight is considered a clear reflection of both the RLT and the VGH, therefore the significant increase in the FW was found through the 12 days growth life duration at "T_{26}".

Since, the remarked changes in the means of the DMP are not copying with the remarked changes in the growth life, therefore using the DMP only as main criteria to determine the beast treatment is considered technical mistake. Since the means of the DMW are demined by multiplying the means of the FW and DMP, therefore the DMW is considered great criteria to determine the beast treatment. According to this criteria "DMW", the treatment No. "T_{14}" which containing highest value of the DMW "0.950kg" with significant different comparing with the other treatments at $p<0.05$ is considered the beast treatment.

Figs (1a), (1b), and (1c) show that at the three levels of the growth life durations "8, 10, and 12 days" the fresh weights mean (kg) of the hydroponics sprouted barley production are increased significantly at $p<0.005$. This is due to the increase of the means of the media weights "Rough, Medium, and Fine rice straw" from 0.125 to 0.375 kg. The medium media with the physical specification "mean length of rice straw is less than 5cm" executes the highest values of increasing for the three growth life durations. Technically, this improvement could related to three main factors. The first is the rice straw media is a biomass containing complex components and elements could be chemically analyzed by microorganism enzymes into simple components and elements. The second is the rice straw media has high capacity to absorb high amounts of water and its nutrition during the irrigation process. The third is the rice straw media has high capability to deliver the absorbed water and nutrition to the sprouts trough the irrigation interval. These causations are in agreement with that were mentioned by **Bakker et al. 2013, Kargbo et al. 2010, and Nader and Robinson 2010.**

Figs (2a), (2b), and (2c) show that the fresh weights mean (kg) of the hydroponics sprouted barley production are increased significantly at $p<0.005$ due to the increase of the growth life durations “8, 10, and 12 days”. Technically, this improvement could related to one reason. This reason is increasing the growth life duration means increasing the total time for photolysis process, water and nutrition absorption, and roots, leaves, stems construction process. These figures show that using the medium media executes significant increase at $p<0.05$ in barley fresh weight comparing with the remarked increase by using the rough and the fine media. This is due to the rough media has a small capacity to absorb and deliver water and nutrition.

Table (2a): Statistical analysis results for the trails data:

Treatments	Variables means and its ranks				
	RLT cm	**VGH cm**	**FW kg**	**DMP%**	**DMW kg**
T_1	3^{ghi}	15^{g}	3.500^{l}	$13.00^{e\text{-}g}$	0.455^{l}
T_2	2^{lmn}	16^{fg}	$4.250^{i\text{-}l}$	$14.17^{b\text{-}f}$	0.595^{j}
T_3	2^{n}	16^{def}	3.800^{kl}	16.50^{a}	0.577^{k}
T_4	4^{efg}	17^{efg}	$5.250^{g\text{-}i}$	$13.580^{d\text{-}g}$	0.709^{g}
T_5	3.4^{igk}	18^{def}	$5.650^{e\text{-}h}$	$15.50^{a\text{-}d}$	0.876^{b}
T_6	2.5^{lmn}	19^{cde}	$5.450^{f\text{-}h}$	$15.00^{a\text{-}d}$	0.818^{d}
T_7	5^{bcd}	18^{def}	$6.450^{f\text{-}h}$	$11.70^{g\text{-}i}$	$0.755f^{r}$
T_8	4.4^{de}	18^{def}	$4.850^{h\text{-}k}$	$11.00^{h\text{-}j}$	0.754^{f}
T_9	4^{efg}	19^{cde}	$6.85^{b\text{-}d}$	9.70^{j}	0.665^{h}
T_{10}	3.1^{igk}	17.7^{def}	$4.250^{i\text{-}l}$	$15.00^{a\text{-}d}$	0.638^{i}
T_{11}	2.8^{klm}	19^{cde}	$5.000^{g\text{-}j}$	$15.00^{a\text{-}d}$	0.750^{f}
T_{12}	2.4^{mn}	20^{bcd}	$4.550^{h\text{-}l}$	16.50^{a}	0.751^{f}
T_{13}	4.2^{ef}	19^{cde}	$4.950^{h\text{-}k}$	$14.00^{c\text{-}f}$	0.833^{d}
T_{14}	3.8^{hi}	21^{abc}	$6.500^{c\text{-}f}$	$14.67^{a\text{-}e}$	0.950^{a}
T_{15}	2.9jkl	22ab	6.150d-g	14.17b-f	0.867bc

Table (2a): continued:

Treatments	Variables means and its ranks				
	RLT cm	VGH cm	FW kg	DMP%	DMW kg
T_{16}	5^{abc}	19^{abc}	6.700^{c-e}	13.00^{e-g}	0.878^{b}
T_{17}	4.8^{bcd}	21^{abc}	7.000^{b-d}	12.00^{gh}	0.857^{c}
T_{18}	4.3^{def}	21^{abc}	6.850^{b-d}	12.50^{f-h}	0.857^{c}
T_{19}	3.5^{g}	20^{bcd}	4.750^{h-k}	14.00^{c-f}	0.665^{h}
T_{20}	3.2^{ijk}	21^{ab}	5.250^{g-i}	15.00^{a-d}	0.788^{e}
T_{21}	2.4^{mn}	22^{ab}	4.000^{j-l}	16.00^{ab}	0.640^{i}
T_{22}	4.5^{cde}	21^{abc}	6.500^{c-f}	13.50^{d-g}	0.878^{b}
T_{23}	4.1^{ef}	22^{ab}	7.250^{a-d}	10.00^{ij}	0.870^{bc}
T_{24}	3.5^{g}	23^{a}	6.850^{b-d}	12.50^{f-h}	0.870^{bc}
T_{25}	5.5^{a}	21^{abc}	7.850^{ab}	10.00ij	0.795^{c}
T_{26}	5^{abc}	22^{ab}	8.300^{a}	10.00^{ij}	0.830^{d}
T_{27}	4.5^{cde}	23^{a}	7.500^{a-c}	10.00^{ij}	0.760^{f}
±SE	**0.109**	**0.262**	0.591	6.77E-03	7.16E-03

Note: a, b, c, d, e, f, g, and h: Means in the same column with different superscripts are significant different ($P<0.05$). **RLT** is Root Layer Thickness (cm)**, VGH** is Vegetation Growth High (cm)**, FW** is Fresh Weight (kg)**, DMP** is Dry Matter Percentage (%), and **DMW** is Dry Matter Weight (kg). The DMP "Ratios" were statistically analyzed as Arc SIN data.

Table (2b): continued:

Treatments	Variables means and its ranks				
	Ash%	Cp%	Cf%	EE%	NFE%
T_{1}	7.7^{g}	12.5^{fg}	22^{c}	2.5^{b}	44.3^{de}
T_{2}	8.0^{fg}	12.4^{g}	22.5^{bc}	2.7^{ab}	45.6^{cde}
T_{3}	8.5^{efg}	12.8^{efg}	23^{ab}	2.9^{a}	47.2^{bcde}
T_{4}	9^{defg}	12.8^{efg}	19.7^{d}	2.4^{cde}	43.9^{e}
T_{5}	9.3^{cdef}	$13,5^{def}$	24^{abc}	2.6^{abc}	49.4^{a}
T_{6}	8.7^{efg}	14^{cd}	24.5^{abc}	2.7^{abcd}	49.8^{bcde}
T_{7}	10.8^{abc}	12.8^{efg}	24^{abc}	2.8^{abc}	50.4^{bcde}
T_{8}	11^{abc}	13.2^{defg}	24.3^{abc}	2.4^{cdef}	50.9^{bcd}
T_{9}	10.5^{abc}	12.5^{fg}	24.6^{ab}	2.5^{bcde}	50.1^{bcde}
T_{10}	9^{defg}	13.6^{de}	23^{abc}	2.4^{cdef}	48^{bcde}
T_{11}	9^{defg}	14.2^{bcd}	23.5^{abc}	2.5^{bcde}	49.2^{bcde}
T_{12}	10^{bcde}	14^{cd}	23.2^{abc}	2.7^{abcd}	49.9^{bcde}
T_{13}	9.5^{cdef}	15.1^{b}	23.5^{abc}	2.3^{def}	50.4^{bcde}
T_{14}	11^{cde}	16.3^{b}	24^{abc}	2.4^{cdef}	52.7^{abcd}
T_{15}	10^{abc}	15.3^{a}	24.5^{abc}	2.5^{bcde}	52.3^{ab}

Table (2b): continued:

Treatments	Variables means and its ranks				
	Ash%	**Cp%**	**Cf%**	**EE%**	**NFE%**
T_{16}	11.5^{ab}	14ab	24.5^{abc}	2.3^{def}	52.3^{abc}
T_{17}	11^{abc}	14.6^{bc}	24.2^{ab}	2.5^{bcde}	52.5^{abcde}
T_{18}	11^{abc}	13.8^{bc}	25.2^{a}	2.5^{bcde}	52.5^{abc}
T_{19}	9.7^{cde}	13.5^{def}	23.5^{abc}	2.3^{def}	48.9^{bcde}
T_{20}	9.7^{cdef}	13.6^{de}	24^{abc}	2.4^{bcde}	49.7^{bcde}
T_{21}	10^{bcde}	13.9^{cd}	24.5^{abc}	2.5^{bcde}	50.9^{bcd}
T_{22}	11^{abc}	13.6^{de}	23.5^{abc}	2.2^{fg}	50.27^{bcde}
T_{23}	11^{abc}	14^{de}	24.5^{abc}	2.2^{ef}	51.7^{abcd}
T_{24}	10.7^{abcd}	14.2^{bcd}	24.8^{ab}	2.1^{fg}	51.7^{abcd}
T_{25}	11.9^{a}	13.2^{defg}	24.7^{ab}	1.9^{gh}	51.7^{abcd}
T_{26}	11.7^{ab}	13.2^{defg}	24.8^{ab}	1.9^{gh}	$51,7^{abcd}$
T_{27}	12^{a}	13.6^{de}	25.2^{a}	1.7^{h}	52.6^{abc}
±SE	**0.148**	**0.093**	**0.120**	**0.292**	**0.275**

Note: a, b, c, d, e, f, g, and h: Means in the same column with different superscripts are significant different ($P<0.05$). Ash is ash percentage %, Cp is crude protein percentage %, EE is ether extract percentage %, and NFE is nitrogen free ether percentage %. The all ratios were statistically analyzed as Arc-SIN-data.

Also. since the fine media has very high capability to keep a big amounts of water and nutrition. Therefore, this media will be a suitable zone for growing the hazard fungi causing yellow color and weight loss of the sprouts. The remarked improvement in the quantity and its causation is in coping with that was mentioned by **Sarnklong et al. 2010.** According to the above results and its discussions, using medium media (85%less than 5cm) with 50% Ratio between rice straw weigh to dry grains weight through 10 days growth life duration gives great weights of the hydroponics sprouted barley production.

3.2. Effects of using rice straw media on the quality of production:

Figs (3a), (3b), and (3c) show that the medium media with physical specification (rice straw less than 5cm) give significant increase in the mean of the dry matter weights (kg) at $p<0.05$ comparing with the rough and the fine media. Statistically, this increase is significant at $p<0.05$ through the 10 days growth life duration comparing with the 8 and the 12 growth life.

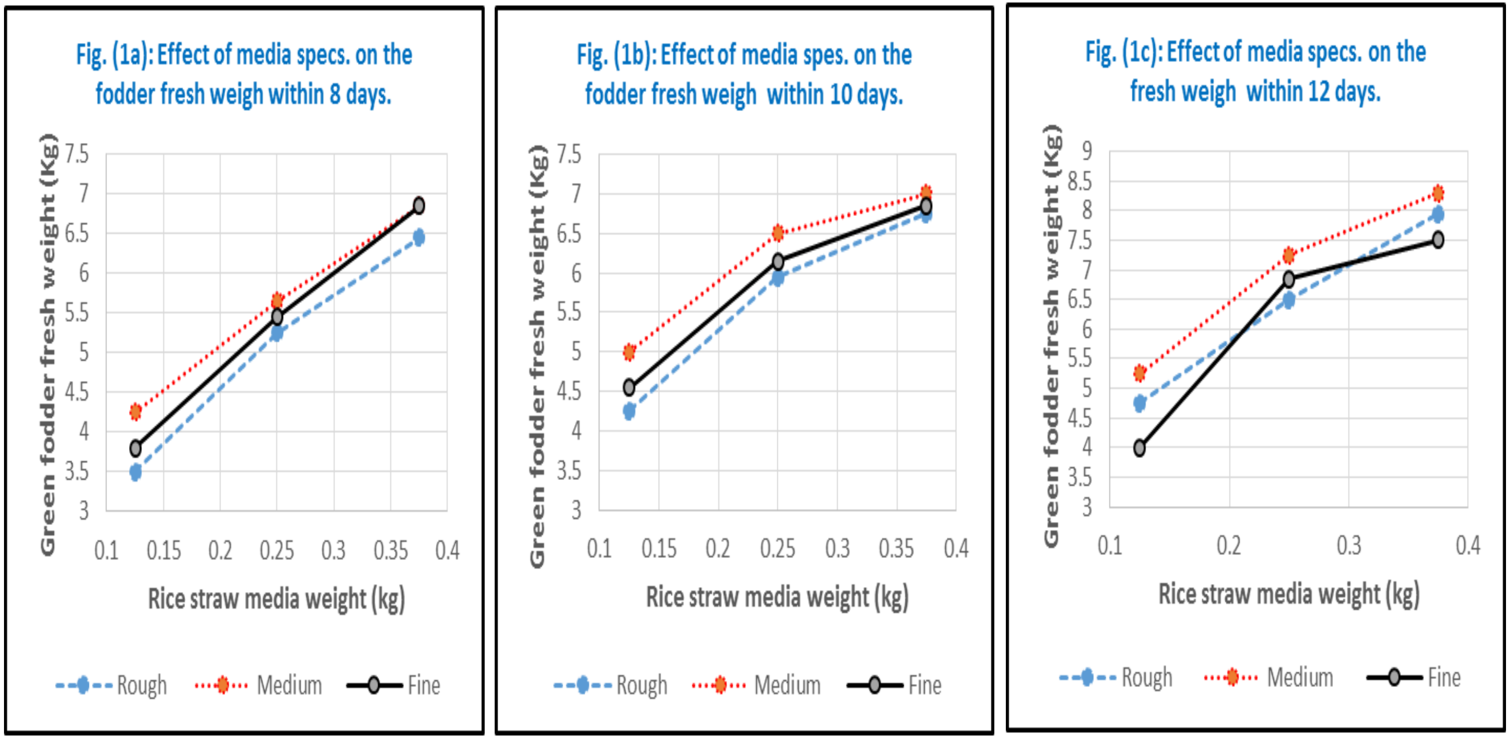


Fig. (1): Effect of media specifications on the fodder fresh weight.

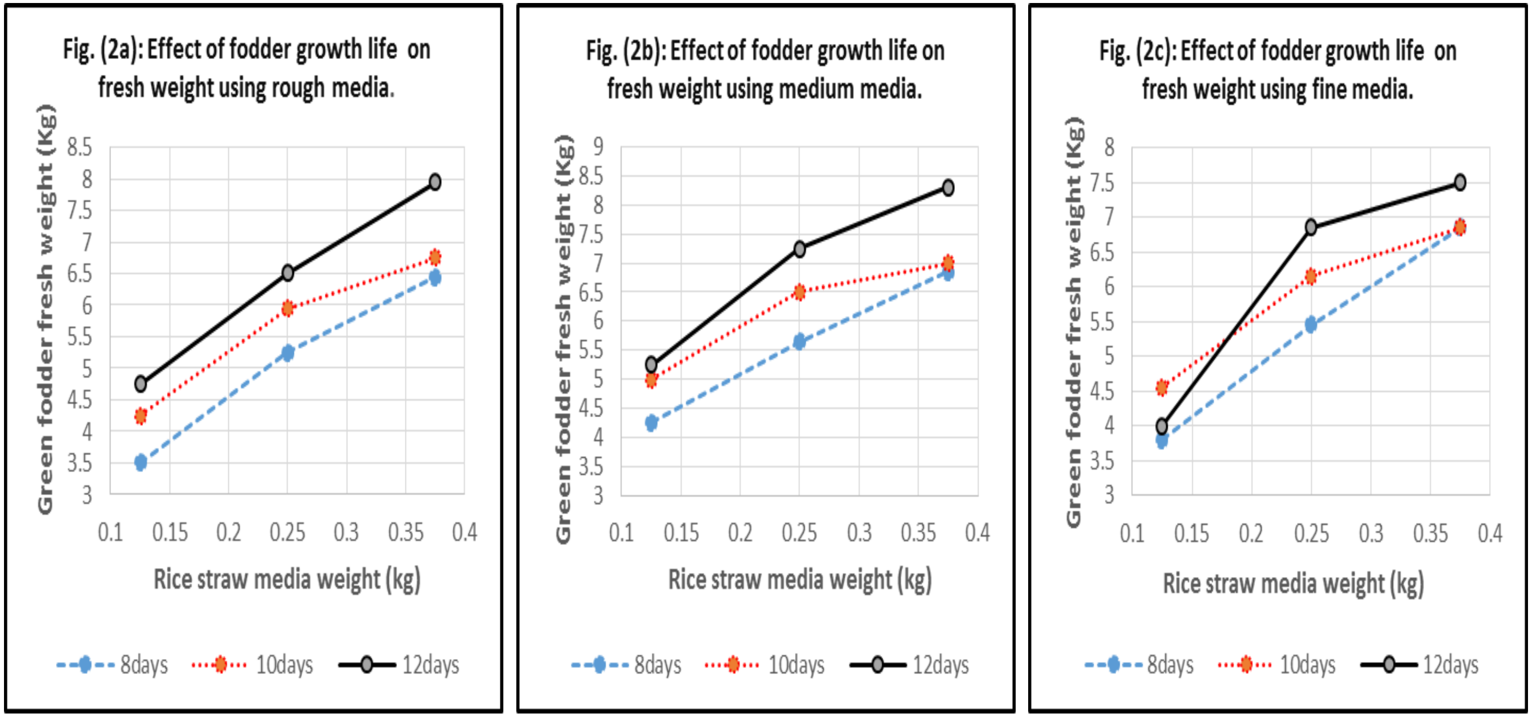


Fig. (2): Effect of the fodder growth life on fodder fresh weight.

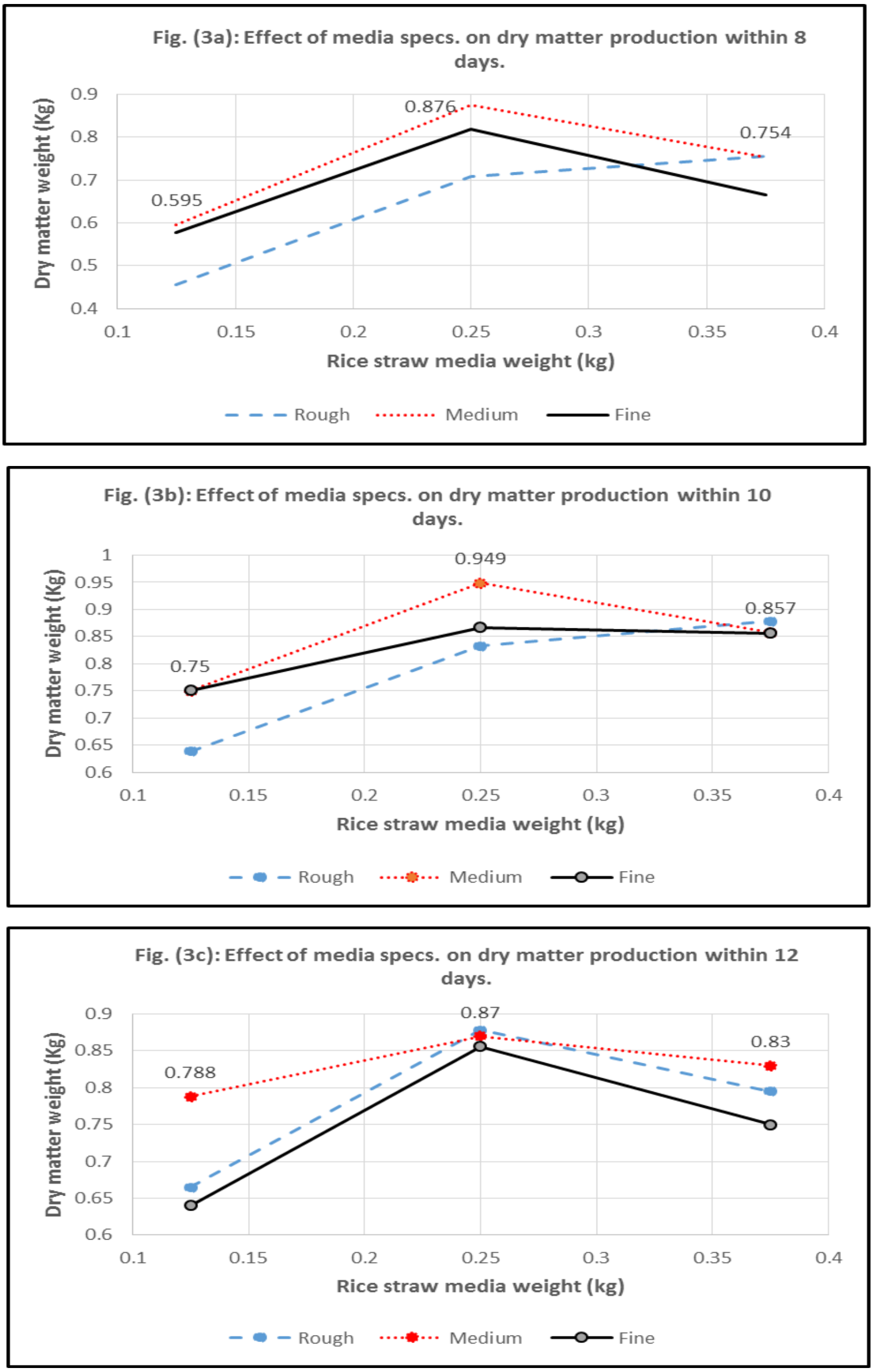
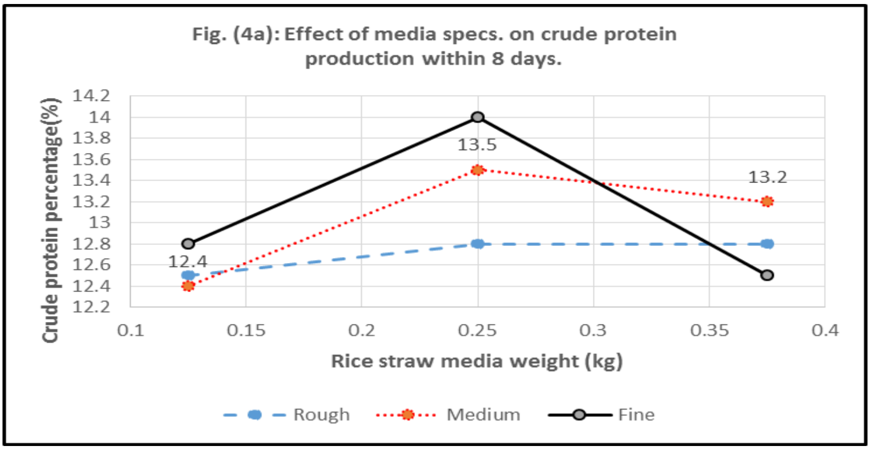
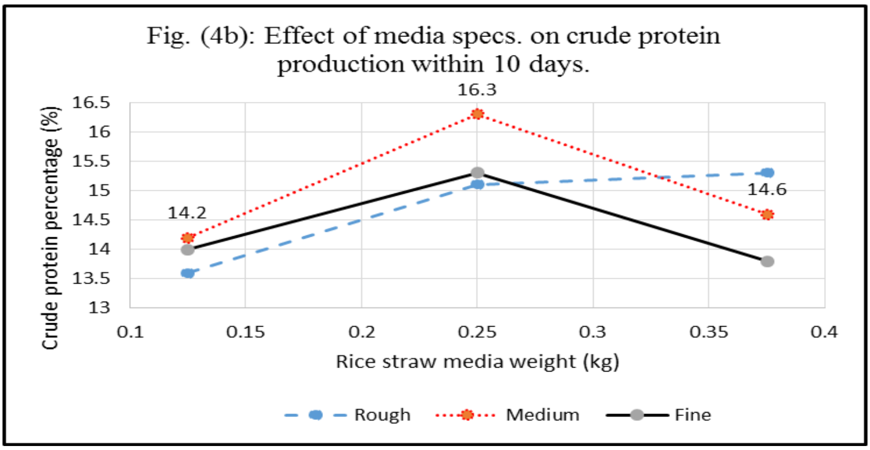


Fig. (3): Effect of media specifications on fodder dry matter weight.





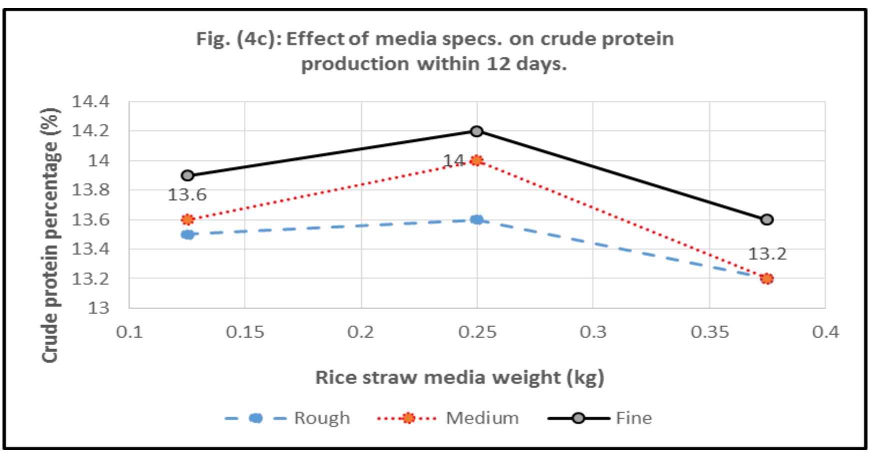


Fig. (4): Effect of media specs on fodder crude protein percentage.

This increase is significant at $p<0.05$ through using 50% ratio between rice straw media weight to dry grains weight comparing with the 25% and the 75% ratios. As a result, using medium media at ratio of 50% through 10 days growth life duration gives maximum value of dry matter. This maximization is related to the ideal conditions of the medium media keeping and delivering nutrition to the sprouts, and minimizing the hazard fungi growth.

Generally, Figs (4a), (4b), and (4c) show that the means of the crude protein percentages are increased significantly at $p<0.05$ by increasing of the rice straw media weights through the weights from 0.125 to 0.250 kg. Irreversibly, these percentages are decreased significantly at $p<0.05$ by increasing of the rice straw media weights through the weights from 0.250 to 0.375 kg. These Figs show that the crude protein curves of medium media are transferred among the intermediate, the top, and the intermediate positions for the 8, 10, and 12 growth life duration respectively. Fortunately, the maximum mean of the crude protein percentages are found by using medium media with 50% ratio between rice straw weight and barley grains weight through 10 days growth life duration. This maximization is due to highly activation of microorganisms inside the suitable media containing balanced moisture, nutrition, and air.

Table (2b) shows that the Ash percentage means are continuously increased from 7.7 to 12% by increasing the growth life duration. This continuously increase is due to the continuously absorption of salts and minerals by the sprouts during the growth life duration. The crude fiber percentage mean are continuously increased from 22 to 25% by increasing the growth life duration. This continuously increase is due to the continuously composition of fibers in the sprouts during the growth life duration. The Ether Extract percentage mean are continuously decreased from 2.5 to 1.7% by increasing the growth life duration. Ether Extract within 1.5 to 3% is considered activation components to the digestion inside the animals' stomach. Fortunately, the EE percentage of the ideal treatment T_{14} is located inside the suitable range for digestion. Nitrogen Free Ether percentage means are continuously increased from 44.3 to 52.7% by increasing the growth life duration. This component is used for protein compositions by the barley sprouts. Fortunately, the NFE percentage of the ideal treatment T_{14} is located inside the suitable range for suitable digestion. Therefore, the highest value of the crude protein means is found at the ideal treatment $T_{14.}$

According to the above results and its discussions, using medium media (85%less than 5cm) with 50% Ratio between rice straw weigh to dry grains weight through 10 days growth life duration gives high quality of the hydroponics sprouted barley production.

3.3. Effects of recycling rice straw in the hydroponics sprouted barley production on Greenhouse Gases Emission :

According to this research results (T_{14}), production of 6.5 kg of the fresh hydroponics sprouted barley is recycling 0.50 kg of rice straw. In other meaning (production of 1ton fresh green barley is recycling 76.923 kg of rice straw). Default values for emission factors for rice residues open burning are 118.5, 113.2, 2.7, 0.07, 3.1, 27.63, and 13, 0.69 Gef (g kg-1dm) of CO, CH4, N2O, CO_2, NO_x, $PM_{2.5}$, PM_{10}, and Black Carbon respectively, **Farag et al. 2013**. Due to lack of knowledge, facilities, and effective recycling systems in Egypt, the total rice straw burnt area is 353086 ha of the total area cultivated with rice "588477 ha", **Farag et al. 2013**. Therefore, the need to use the rice straw media for the hydroponics sprouted barley production is considered critical issue for charring in the food security and minimizing the greenhouse gases emissions. This discussion is coping with that was concluded by **Helal and Hassan 2013a, 2013b.** Green fodder could be produced by sprouting on roughages like date palm leaves and potatoes peels waste and roughages like leucaena leucocephala and olive tree pruning as a media. Using fungi and enzyme treatments is expected to be a practical, cost-effective and environmental-friendly approach for enhancing the nutritive value and digestibility of rice straw, **Malik et al. 2015**.

According to the above results and its discussions, using the rice straw as a bio-media for the hydroponics sprouted barley production minimizing the greenhouse gases emissions through minimizing the open-field burning.

CONCLUSION

According to the research results copying with logic concepts and supported by the previous researches, this research results could be summarized as follows:

(1) Using medium media (85%less than 5cm) with 50% ratio between rice straw weigh to dry grains weight through 10 days growth life duration gives great weights of the hydroponics sprouted barley production “fresh weights and its dray matter”.

(2) Using the same media with the same specifications gives high quality of the hydroponics sprouted barley production (Ash percentage, crude protein percentage, ether extract percentage, and nitrogen free ether percentage).

(3) Using the rice straw as a bio-media for the hydroponics sprouted barley production minimizing the greenhouse gases emissions through minimizing the open-field burning (CO, CH4, N2O, CO_2, NO, $PM_{2.5}$, PM_{10}, and Black Carbon).

As a results, the research recommendation for developing the quantitative and qualitative specifications of hydroponics sprouted barley production and conserving the natural environment is: Using the rice straw as a bio-media for hydroponics sprouted barley production with technical specification of “rice straw length is equal to or less than 5cm, ratio between rice straw and dry grains weight is equal to 50%, and growth life production is equal to 10 days” for developing the hydroponics sprouted barley production and conserving the environment.

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الملخص العربى

تدوير قش الأرز لتنمية إنتاج الشعير المستنبت مائيا والحفاظ على البيئة

خالد خليل حجاب*

يشكل الحرق المباشر لقش الأرز داخل الحقول المفتوحة والذى يتم حتى الأن مصدراُ رئيسيا لتلوث البيئة، وذلك لعدم قناعة المزارع بوسائل التدوير المعروضة عليه. كما أنه يصعب تحقيق أمن غذائى من اللحم واللبن دون زيادة أعداد الحيوانات الكبيرة "الأبقار والجاموس" والتى تحتاج الى كميات كبيرة من الأعلاف الخضراء. ونظرا لمحدودية الموارد المائية والأرضية فإن تنمية إنتاج الأعلاف الخضراء بالحقول المفتوحة من الأشياء المستحيلة. وحيث أن إنتاج الأعلاف الخضراء داخل وحدات الإستنبات يحقق تكثيف عالى جداَ لإستخدام الموارد المائية والأرضية، فإن تنمية إنتاج الأعلاف الخضراء بإستخدام وحدات الإستنبات من الأشياء الممكنة. وذلك لأن وحدات الإستنبات لا تنافس المحاصيل الحقلية فى مساحة الأراضى الزراعية، كما أن إستهلاكها محدود جدا من الموارد المائية.

يهدف هذا البحث الى تنمية إنتاج الشعير المستنبت مائيا بإستخدام تبن قش الأرز كبيئة عضوية. وهذا من أجل تلبية إحتياجات الحيوانات الكبيرة "الأبقار والجاموس" من الأعلاف الخضراء، وتقليل التلوث الناتج من عملية الحرق المباشر. ولتحقيق الهدف المنشود تم إستخدام منهج التحليل الإحصائى وذلك بتصميم وتنفيذ وتحليل نتائج تجربة بحثية إحصائيا وفقا لنظام التجارب العاملية كاملة القطاعات العشوائية تتكون من ٢٧ معاملة. بواقع ثلاث معاملات مرتبطة بالمواصفات الفيزيائية لتبن قش الأرز وهما تبن ناعم بطول يساوى أو أقل من ٢.٥ سم، تبن متوسط الخشونة بطول يساوى أو أقل من ٥.٠ سم، وتبن خشن بطول يساوى أو أقل من ٧.٥ سم. ثلاث معاملات مرتبطة بالنسبة بين وزن القش الى الحبوب الجافة وهما ٢٥%، ٥٠%، ٧٥%. ثلاث معاملات مرتبطة بمدة فترة النمو داخل وحدات الإستنبات وهما ٨، ١٠، ١٢ يوم. وتم إجراء جميع التجارب بوحدة إنتاج الأعلاف الخضراء المستنبت بقسم الهندسة الزراعية - كلية الزراعة جامعة القاهرة.

***أستاذ مساعد- قسم الهندسة الزراعية - كلية الزراعة – جامعة القاهرة**

وتم إجراء قياسات هندسية خاصة بكمية الإنتاج وأخرى كيمائية حيوية خاصة بجودة الإنتاج. وإشتملت القياسات الخاصة بكمية الإنتاج على: سمك طبقة الجذور(سم)، وإرتفاع المجموع الخضرى (سم)، الوزن الرطب للمجموع الخضرى والجذرى (جم)، والوزن الجاف للمجموع الخضرى والجزور (جم). وإشتملت القياسات الخاصة بجودة الإنتاج على: نسبة الرماد ، ونسبة البروتين القابل للهضم ، ونسبة الألياف القابلة للهضم، ونسبة الإثير المستخلص، ونسبة النيتروجين خالى الإثير. وتم تحليل جزء من العينات بالمعمل المركزى لكلية الزراعة جامعة القاهرة، وجزء بالمعمل المركزى لتحليل الأعلاف بمركز البحوث الزراعية، وجزء بمعامل كلية الطب البيطرى جامعة القاهرة، وجزء بقطاع الأمن الغذائى للقوات المسلحة.

اوضحت نتائج التحليل الإحصائى أن إستخدام تبن قش الأرز متوسط الخشونة بطول يساوى أو أقل من ٥.٠ سم، بنسبة مقدارها ٥٠% بين وزن القش الى الحبوب الجافة، ولمدة ١٠ أيام داخل وحدات الإستنبات يعطى أكبر كمية من الأعلاف الخضراء بأعلى مواصفات للجودة . وبناء عليه فإن إستخدام النتائج التطبيقية لهذا البحث تساهم بدرجة كبيرة فى تحقيق الأمن الغذائى وتقلل من التلوث الناتج من عملية الحرق المباشر.