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QUALITY PROPERTIES FOR COTTON STALKS AND RICE STRAW BRIQUETTES.

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ABSTRACT

The agricultural crop residuals are considered one of the most important problems, which face the environmental life and farmers in Egypt. The mechanical treatment by cutting, crushing or chopping and briquetting processes are the primary step and the suitable solution for solving this problem and recycling these residuals to be transformed into useful products. So the aim of the present work to get a high quality for cotton stalks and rice straw briquettes. Chopped cotton stalks and rice straw having moisture content (8, 10 and 12%) and (8, 10 and 12.8% w.b.) were densified into briquettes without binder and with binder (Urea-Formaldhyde) using a screw press machine. Quality properties for briquettes were durability, compression ratio hardness, bulk density, compression ratio, resiliency, water resistance and gases emission. The optimum quality properties found for briquettes at 8 % moisture content and without binder. Where the highest compression stress and durability were 8.95, 10.39 MPa and 97.06 %, 93.64 % for cotton stalks and rice straw briquettes, respectively. The CO and CO_2 emissions for cotton stalks and rice straw briquettes were less than these for loose residuals.

INTRODUCTION

Disposal of farm residues are one of the main problems facing Egyptian farmers which estimates about 30-35 million ton/year **(Shaban and Sawan, 2010)**. Cotton stalk is considered as the one of the main environmental problems in Egypt. It is estimated to be around 0.8 million ton dry every year. Egypt is the largest rice producer in the Near East region, where rice cultivation area occupies over 1,093,303 feddan with an average farm yield of 3.66 tons/feddan and an approximate straw production of 2.3 million tons/year **(MALR, 2010)**.

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Biomass is considered one of the main renewable energy resources of the future due to its large potential, economic viability and various social and environmental benefits. It was estimated that by 2050 biomass could provide nearly 38% of the world's direct fuel use and 17% of the world's electricity (**Demirbas, 2000**). The briquetting technology improves the characteristics of agro-residues for transportation, storage, feeding into furnaces, and combustion (**Werther, *et al* 2000**). The mechanical strength of the briquettes can be improved by adding some biomass samples. For example, the presence of paper mill waste increased the shatter index of the briquettes obtained. Similarly, sawdust and paper mill waste increased compressive strength of the briquettes. Water resistance of the briquettes can be augmented by adding olive refuse, cotton refuse, and pine cone or paper mill waste (**Yamnan, *et al* 2001**). To produce high quality pellets, the feedstock has to be dried to a moisture content of about 10% (raw weight). Since it is not possible to reach such low moisture contents by natural drying, the material has to be artificially dried. However, a wide range of temperatures and retention times can be used in the drying process (**Stahl, *et al* 2004**).To improve the quality of the briquettes and to have an economically competitive product at the same time, the esparto was partially pyrolyzed at temperatures between 160°C and 400°C, and the pressure of densification has been examined. The combustion profile of the samples has been studied by applying the derivative thermogravimetry technique and the mechanical properties of the briquettes were tested to evaluate the impact resistance and water resistance (**Debdoubi, *et al* 2005**). To make the biomass materials available for a variety of applications, the challenges with the use of biomass materials in their original form must be resolved. Because of high moisture content, irregular shape and sizes, and low bulk density, biomass is very difficult to handle, transport, store, and utilize in its original form. One solution to these problems is densification of biomass materials into pellets, briquettes, or cubes. Densification increases the bulk density of biomass from an initial bulk density (including baled density) of 40–200 kgm^{-3} to a final bulk density of 600–800 kg/m^3 (**Mc Mullen, *et al* 2005**). The burning of agricultural wastes causes' air pollution, soil erosion, and a decrease in biological activity, which eventually leads to lower yields. However, burning yields smoke and other pollutants which adversely affect air quality, visibility, and human and environmental health. The low sulphur content of crop residues as compared to fossil fuels and their use as fuel does not add to the CO_2 content of the atmosphere **(Dubey, *et al* 2007)**. Densification process to create strong and durable bonding in densified products such as pellets, briquettes, and cubes can be determined by quality testes which include testing the strength (compressive resistance, impact resistance and water resistance) and durability (abrasion resistance) of the densified products These tests can indicate the maximum force/stress that the densified products can withstand, and the amount of fines produced during handling, transportation and storage **(Nalladurai and Morey 2009)**. The durability of briquettes is a measure of the ability of the briquettes to withstand the destructive forces such as compression, impact and shear during handling and transportation. In addition, the durability values represent the relative strength of the particle–particle bonding in the briquettes/pellets **(Nalladurai and Morey 2010)**. Pellet biomass fuels are compressed, homogenized and dried biomass fuels that possess several advantages during handling, storage and combustion when compared to unprocessed biomass fuels. Environmentally, pellet biomass fuels provide advantages of less ash, smoke and other compound emissions, including carbon particles, CO, NO_x and SO_x. Because the use of biomass pellets produces much fewer greenhouse gases when the biomass is sustainably harvested, there has been a recent push to replace fossil fuels with biomass fuels **(Panwar, *et al* 2011)**.

MATERIALS AND METHODS

Materials

The chopped materials were pressed in a screw press machine at the Shimada Company (Type SPMM-850 KS) as shown Fig. (1) at (8, 10, and 12 %) and (8, 10, and 12.8 %) moisture content for cotton stalks and rice straw with and without binder, respectively. The production capacity of the machine was 400 kg/h. The press machine is powered by 30 kW Electric Motor. It has 2 Electrical Ceramic heater bands each requiring 3 kW for operation and has an integrated "T" Stirrer with a 1.5 kW Motor.

The chopped materials feeded from the container in to the machine by a belt which its velocity was 0.38 m/s.

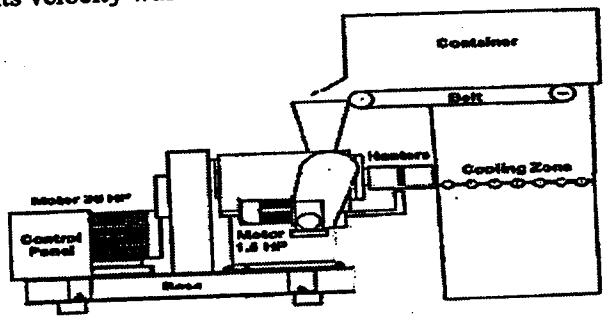


Fig. (2). the Screw press machine.

Cotton stalks

Cotton stalks (*Gossypium Barbadense*) used at three different moisture content (8%, 10 % and 12%). The stem length of cotton stalks ranged from 98 to 182 cm, stem diameter ranged from 7.3 to 15 mm, weight of one stalk ranged from 35 to 200 g and number of branches ranged from 6 to 27.

Rice straw

Rice straw (*Oryza Sativa,* Giza 101) used at three different moisture content (8%, 10 % and 12.8%). The stem average length was 80cm (from 70 to 90 cm), stem diameter ranged from 3 to 4.5 mm and number of branches ranged from 5 to 12.

The binder (urea-formaldehyde)

Urea-formaldehyde (thermal glue) Characterized by the following:

Color : Milky white
Focus : 55 to 66% solids
Density : 1.25 g / cm 3
Viscosity: from 200 - 1000 cm Boaz
PH : 7-8
Percentage of free formaldehyde: not more than 1%

Urea-formaldehyde is added by a rate 10% of the total weight of residues to be pressed.

Measurements

1. Briquettes durability

The durability (Du) of the briquettes was determined according to ASAE Standard S269.4, (2003). A 500 g sample of briquettes was tumbled at 50 rpm for 10 min, in a dust tight enclosure. A No. 5 US Sieve with an aperture size of 4.0 mm was used to retain crumbled briquettes after tumbling. Durability is expressed by the percent ratio of mass of briquettes retained on the sieve after tumbling (mpa) to mass of briquettes tumbling (mpb) according to with the following equation (1). **(Fasina 2008).**

$$Du = \frac{mpa}{mpb} * 100 \quad \cdots\cdots\cdots\cdots\cdots\cdots (1)$$

2. Compression test

The compression stress for each briquette was measured using a universal testing machine (UH-500KN, Shimadzu) as shown Fig. (2). The flat surface of the briquette sample was placed on the horizontal metal plate of the machine. A motorized screw slowly reduced the distance between this metal plate and a second one parallel to it. An increased load was applied at a constant rate until the test sample failed by cracking or breaking. The load at the fracture point and the maximum load were converted to compression stress using the following equation (2). **(Gibiiz, *et al* 1996).**

$$\text{Compression stress} = \frac{\text{Load at fracture}}{\text{Cross sectional area of plane of fracture}} \quad \cdots\cdots (2)$$

The testing machine has the following data:

Type	:Universal testing machine.
Capacity	:500,250,100,50,25,10(kN).
Model	:UH-500KNA.
Working condition	: 1- Voltage : $\pm$ 10%
	2- Warm-Up :15 min.
	3- Temperature : 5- 40^0 C

durability, compression stress, hardness, bulk density, compression ratio, resiliency, water resistance and gases emission.

Quality of briquettes

1. Bulk density (ρ_b)

Bulk density is an indicator of savings in storage, transportation space and cost of blocks. The bulk density of the briquettes was calculated by Eq. (3) using with the sample weight and the measured volume. The volume was determined by the cross sectional area and variable thickness of the blocks. The thickness of blocks, which varies during post-compression recovery. **(Jha *et al* 2008)**

$$\rho_b = \frac{W}{L \times B \times T} \quad \text{.........................} \quad (3)$$

ρ_b = bulk density of cotton stalk briquette, kgm^{-3}
W = weight of cotton stalk briquette, kg
B = width of cotton stalk briquette, mm
L = length of cotton stalk briquette, mm

T = thickness of cotton stalk briquette, mm

2. Compression ratio (CR)

The compression ratio indicates volume reduction during compression. It was obtained from the ratio of bulk density of compact block to the initial density of the material being compressed. According to Eq. (4). **(Jha *et al* 2008)**

$$CR = \frac{\rho_b}{\rho_{raw}} \quad \text{............................} \quad 4)$$

CR = compression ratio
ρ_b = bulk density of cotton stalk briquettes, kgm^{-3}
ρ_{raw} = bulk density of loose cotton stalk, kgm^{-3}

3. Resiliency (R)

Resiliency was determined as the ratio of the increase in thickness to the initial thickness of the briquette according to Eq. (5). **(Jha *et al* 2008)**

$$R = \frac{T - T_i}{T_i} \times 100 \quad \text{.....................} \quad (5)$$

R = resiliency, %
T = thickness of stabilised cotton stalk briquette, mm
Ti= initial thickness of cotton stalk briquette, mm

4. Hardness

Hardness reflects the degree of binding. It was measured as the maximum force recorded while a briquette was broken by a probe incorporated in a Texture Analyser (**Jha *et al* 2008**).

5. Water resistance

The water resistance of the briquettes was tested by immersing them in a glass container filled with cold tap water and measuring the time required for onset of the dispersion in water (**Yamnan, *et al* 2001 and Debdoubi, *et al* 2004**).

RESULTS AND DISCUSSION

Moisture content for cotton stalks and rice straw briquettes

Fig (3) shows that, after the pressing of the chopped cotton stalks and rice straw to briquettes, the moisture content decreased compared with before the pressing. Moisture content of cotton stalks briquettes were pressed at 8, 10 and 12 % decreased to 7.4, 8.57 and 10.35 %, respectively. While moisture content of rice straw briquettes were pressed at 8, 10 and 12.8 % decreased to 7.13, 9.21 and 10.98 %, respectively. The decrement percentages of moisture content were (7.5, 7.9 and 13.75 %) and (10. 87, 12.5 and 8.5 %) for cotton stalks and rice straw briquettes, respectively.

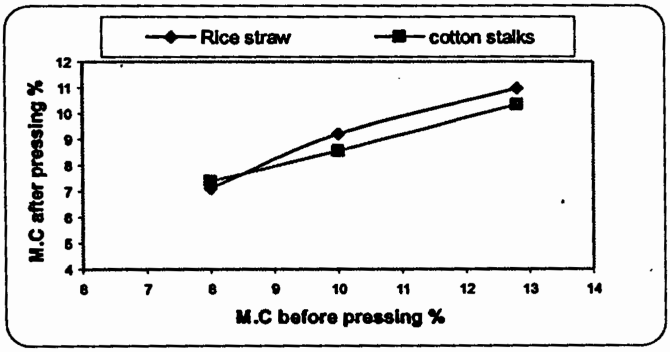


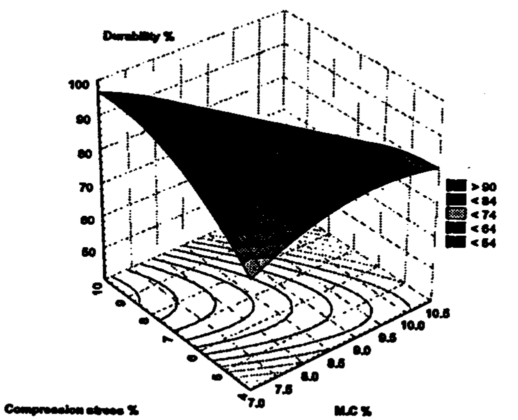
Fig. (3) The effect of pressing on the moisture content of cotton stalks and rice straw briquettes.

Effect of moisture content on compression stress and durability for cotton stalks and rice straw briquettes

The relation between compression stress and durability with moisture content for cotton stalks and rice straw briquettes are shown in Fig. (4a and 4b). It can be noticed that, increase of moisture content decreased the compression stress and durability. And show that, the values of the moisture content and compression stress for briquettes presented as contour (line dark) red on the horizontal plane. It shows the highest values for the durability (□ 90 %), (> 80 %) and (> 94 %), (> 94 %) for cotton stalks and rice straw briquettes, without binder and with binder, respectively.

$$Durability\ \% = -192.6402+44.1899*x+31.6109*y-1.8471*x*x-2.4109*x*y-0.7676*y*y$$

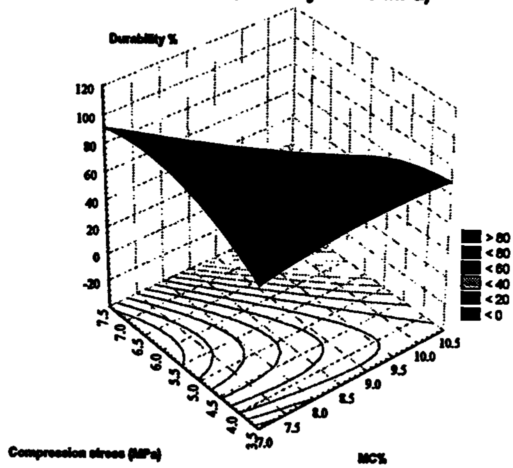
$$(7.4 \leq x \geq 10.35\ \%,\ 4.44 \leq y \geq 8.95\ MPa)$$



Without binder

$$Durability\ \% = -378.5166+55.5382*x+101.6147*y-1.6143*x*x-7.2083*x*y-3.9764*y*y$$

$$(7.4 \leq x \geq 10.35\ \%,\ 3.96 \leq y \geq 7.75\ MPa)$$



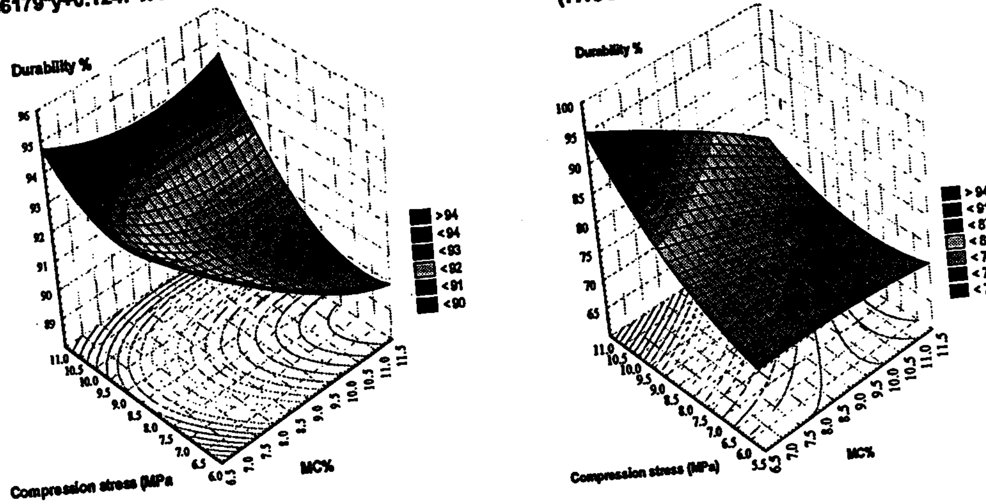
With binder

Fig. (4a) Effect of moisture content on compression stress and durability for cotton stalks briquettes

$$\text{Durability \%} = 135.2403 - 4.3794 \cdot x - 5.6179 \cdot y + 0.1247 \cdot x \cdot x + 0.1888 \cdot x \cdot y + 0.2565 \cdot y \cdot y$$

$$\text{Durability\%} = 678 + 5.2009 \cdot x + 0.3272 \cdot y - 0.1333 \cdot x \cdot x - 0.5945 \cdot x \cdot y + 0.4481 \cdot y \cdot y$$

$$(7.13 \le x \ge 10.98\ \%,\ 5.58 \le y \ge 8.92\ \text{MPa})$$



Without binder

With binder

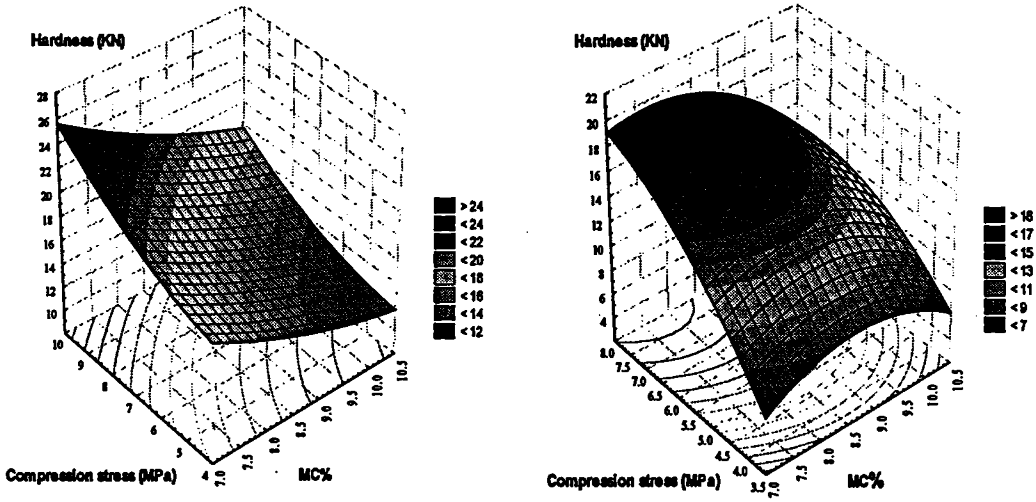
Fig. (4b) Effect of moisture content of compression stress and durability for rice straw

Effect of moisture content on compression stress and hardness for cotton stalks and rice straw briquettes

The relation between compression stress and hardness with moisture content for cotton stalks and rice straw briquettes as shown in Fig. (5a and 5b). It can be noticed that, increase of moisture content decreased the compression stress and hardness. And show that, the values of the moisture content and compression stress for briquettes presented as contour (line dark) red on the horizontal plane. It shows the highest values for the hardness (>24 KN), (> 18 KN) and (>20 KN), (>20 KN) for cotton stalks and rice straw briquettes without binder and with binder, respectively.

Hardness (KN) = 44.4976-5.4253*x+0.1372*y+0.2284*x*x-0.0814*x*y+0.1222*y*y
(7.4 ≤ x ≥10.35 %, 4.44 ≤ y ≥ 8.95 MPa)

Hardness (KN) = -91.2014+17.5205*x+10.0661*y-0.9261*x*x-0.4067*x*y-0.3869*y*y
(7.4 ≤ x ≥10.35 %, 3.96 ≤ y ≥ 7.75 MPa)

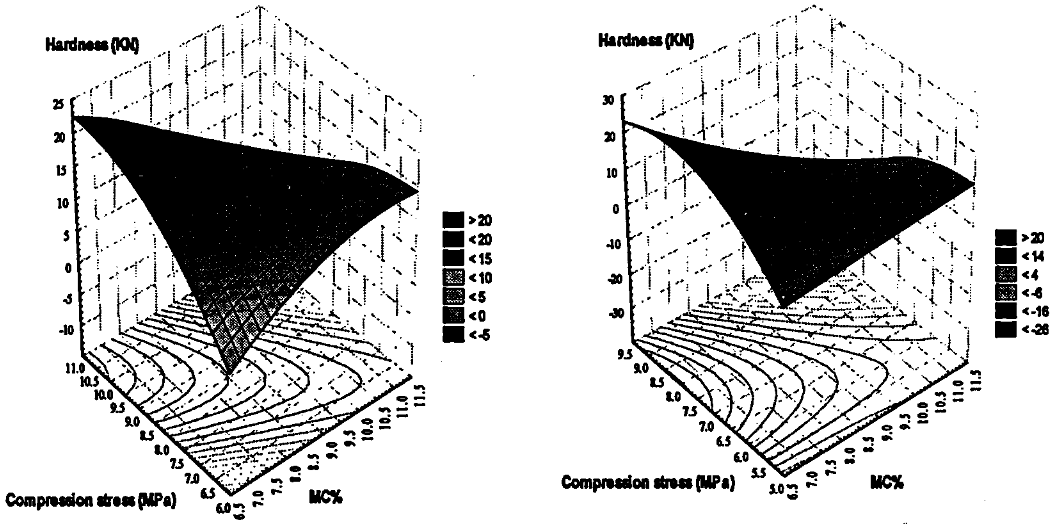


Without binder **With binder**

Fig.(5a) Effect of moisture content on compression stress and hardness for cotton stalks briquettes

Hardness (KN) = -186.401+21.312*x+27.2064*y-0.5582*x*x-1.5249*x*y-0.7957*y*y
(7.13 ≤ x ≥10.98 %, 6.97 ≤ y ≥ 10.39 MPa)

Hardness (KN) = -189.2292+13.5203*x+47.0895*y-0.0386*x*x-2.3861*x*y-1.9266*y*y
(7.13 ≤ x ≥10.98 %, 5.58 ≤ y ≥ 8.92 MPa)



Without binder **With binder**

Fig.(5b) Effect of moisture content of compression stress and hardness for rice straw

Effect of moisture content on compression stress and bulk density for cotton stalks and rice straw briquettes

The measured density of the chopped cotton stalks and rice straw were 0.15 g/cm^3 and 0.035 g/cm^3, respectively. In the other hand, the bulk density of the briquette at moisture content 10.35% and 10.98% were 1.18 and 0.95 g/cm^3. The increment of the density was more than 7 times and 25times, respectively. That means one Ton of the loose material will occupy a storage place of about 6.75 and 25m^3, On the other hand one Ton of the briquette of 10.35 and 10.98% moisture content will occupy a storage place of about 0.87 and 1.05m$^{3.}$ The spare in the storage place of briquettes than the loose materials was about 87 and 95% for cotton stalks and rice straw briquettes, respectively. The relation between compression stress and bulk density with moisture content for cotton stalks and rice straw briquettes are shown in Fig. (6a and 6b). It can be noticed that, increase of moisture content decreased the compression stress and bulk density increased. And show that, the values of the moisture content and compression stress for briquettes presented as contour (line dark) red on the horizontal plane. It shows the highest values for the bulk density, (>1 g.cm^{-3}), (> 0.8 g.cm^{-3}) and (> 0.8 g.cm^{-3}), (> 0.8 g.cm^{-3}) for cotton stalks and rice straw briquettes, without binder with binder, respectively.

Effect of moisture content on compression stress and compression ratio for cotton stalks and rice straw briquettes

The relation between compression stress and compression ratio with moisture content for cotton stalks and rice straw briquettes are shown in Fig. (7a and 7b). It can be noticed that, increase of moisture content decreased the compression stress and compression ratio increased. And show that, the values of the moisture content and compression stress for briquettes presented as contour (line dark) red on the horizontal plane. It shows the highest values for the compression ratio, (>7), (>6) and (>23), (>22) for cotton stalks and rice straw briquettes without binder and with binder, respectively.

Effect of moisture content on compression stress and resiliency for cotton stalks and rice straw briquettes

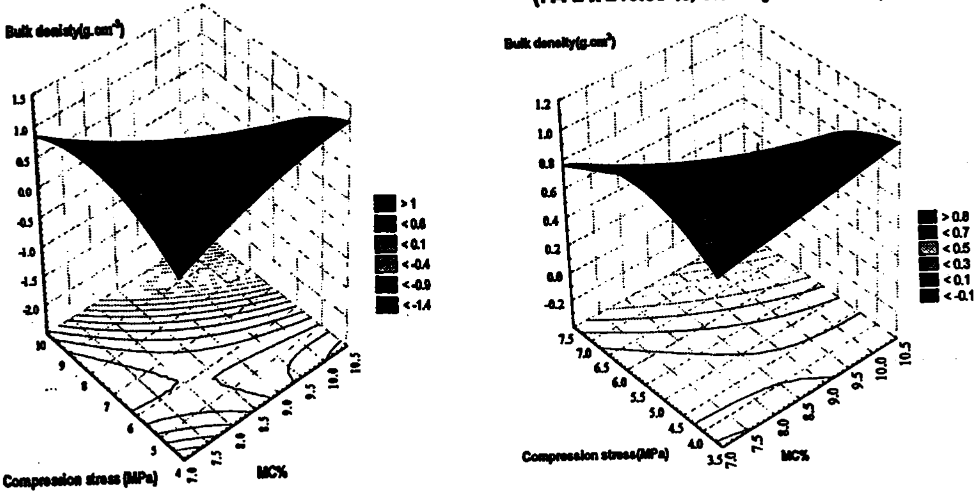
The relation between compression stress and resiliency with moisture content for cotton stalks and rice straw briquettes are shown in Fig. (8a and 8b). It can be noticed that, increase of moisture content decreased the compression stress and resiliency increased. And show that, the values of the moisture content and compression stress for briquettes presented as contour (line dark) red on the horizontal plane. It shows the highest values for the resiliency (>10), (>12) and (> 19), (>14) for cotton stalks and rice straw briquettes without binder and with binder, respectively.

Briquettes water resistance

The relation between water resistance and moisture content for cotton stalks briquettes and rice straw briquettes are shown in Fig. (9a and 9b). It can be noticed that, increase moisture content decreased water resistance. The increment percentage of water resistance for cotton stalks briquettes was 16.17% and 73.53% during decreasing of moisture content from 8.57 % to 7.4% and from10.35% to 7.4%, respectively, at without binder. While the increment percentage of water resistance for rice straw briquettes 26.19% and 65.47% during decreasing of moisture content from 9.21% to 7.13% and from10.98% to 7.13%, respectively, at without binder.

Bulk density (g.cm^{-3}) = 5.5754-0.1694*x-1.1684*y-0.0019*x*x+0.0406*x*y+0.0507*y*y
(7.4 ≤ x ≥10.35 %, 4.44 ≤ y ≥ 8.95 MPa)

Bulk density (g.cm^{-3}) = 3.1059+0.3306*x+1.1893*y+0.0002*x*x-0.0776*x*y-0.0588*y*y
(7.4 ≤ x ≥10.35 %, 3.96 ≤ y ≥ 7.75 MPa)

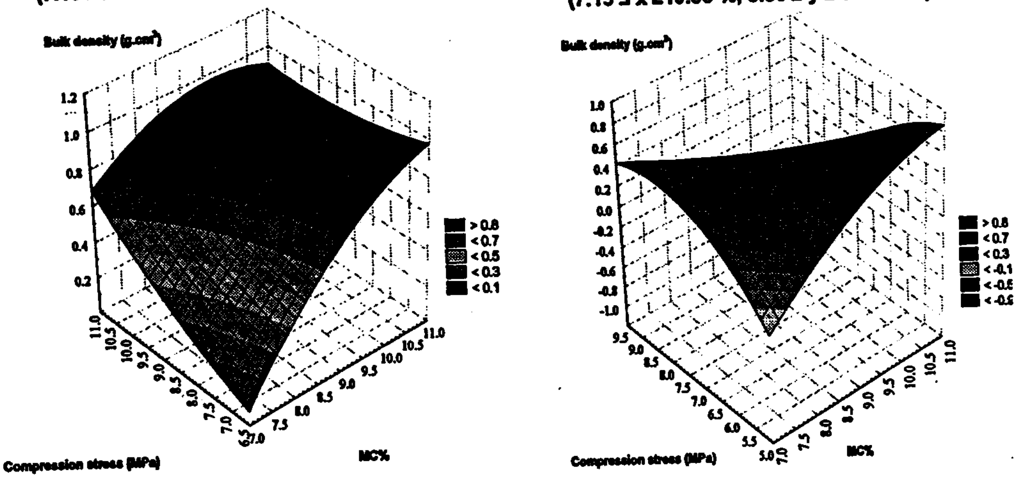


Without binder **With binder**

Fig.(6a) Effect of moisture content on compression stress and bulk density for cotton stalks briquettes

Bulk density (g.cm^{-3}) = -6.3688+1.1638*x+0.2299*y-0.0385*x*x-0.0377*x*y+0.0096*y*y
(7.13 ≤ x ≥10.98 %, 6.97 ≤ y ≥ 10.39 MPa)

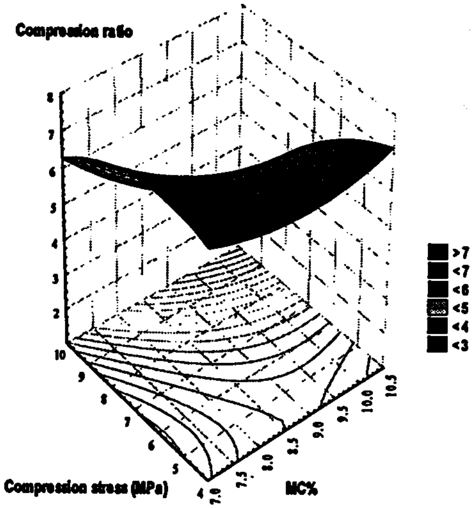
Bulk density (g.cm^{-3}) = -13.6873+1.7566*x+1.9376*y-0.0464*x*x-0.1331*x*y-0.0606*y*y
(7.13 ≤ x ≥10.98 %, 5.58 ≤ y ≥ 8.92 MPa)



Without binder **With binder**

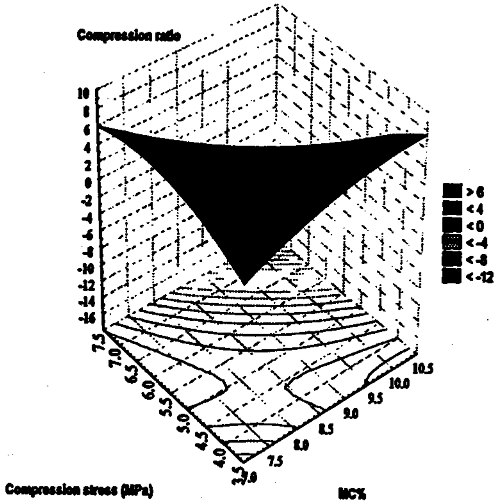
Fig.(6b) Effect of moisture content on compression stress and bulk density for rice straw briquettes

Compression ratio = 12.5982-2.2256*x+2.0061*y+0.161*x*x-0.1575*x*y-0.0767*y*
($7.4 \le x \ge 10.35$ %, $4.44 \le y \ge 8.95$ MPa)



Without binder

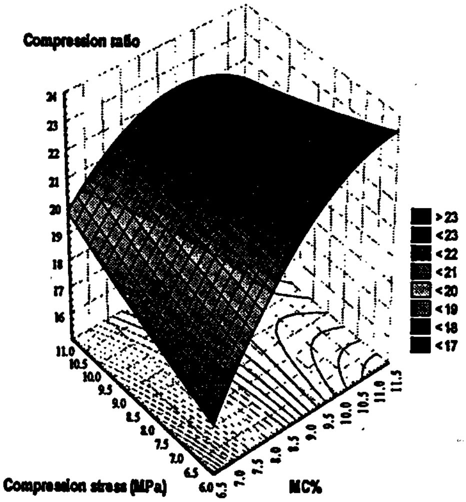
Compression ratio = -100.631+14.917*x+19.6151*y-0.4235*x*x-1.7128*x*y-0.6096*y*y
($7.4 \le x \ge 10.35$ %, $3.96 \le y \ge 7.75$ MPa)



With binder

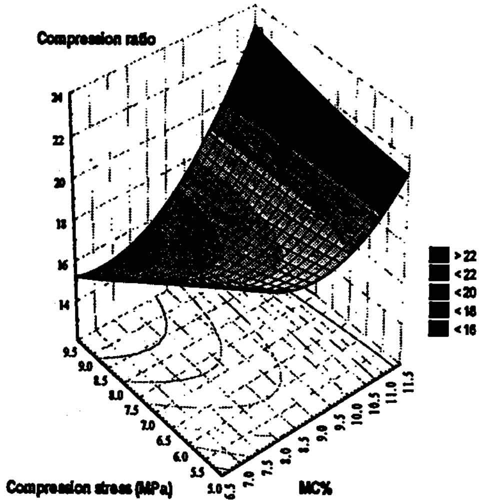
Fig.(7a) Effect of moisture content on compression stress and compression ratio for cotton stalks briquettes.

Compression ratio = -21.349+7.1761*x+1.6143*y-0.2583*x*x-0.2007*x*y+0.0163*y*y
($7.13 \le x \ge 10.98$ %, $6.97 \le y \ge 10.39$ MPa)



Without binder

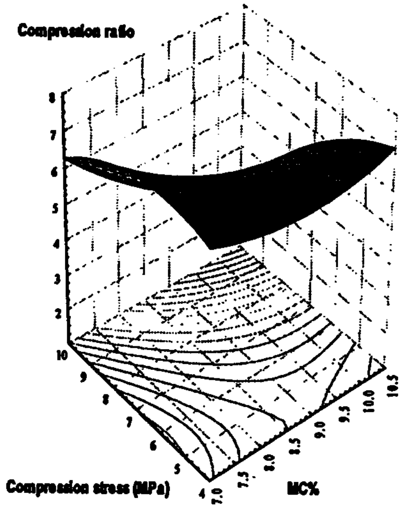
Compression ratio = 74.7705-9.5309*x-4.4741*y+0.4299*x*x+0.3531*x*y+0.0549*y*y
($7.13 \le x \ge 10.98$ %, $5.58 \le y \ge 8.92$ MPa)



With binder

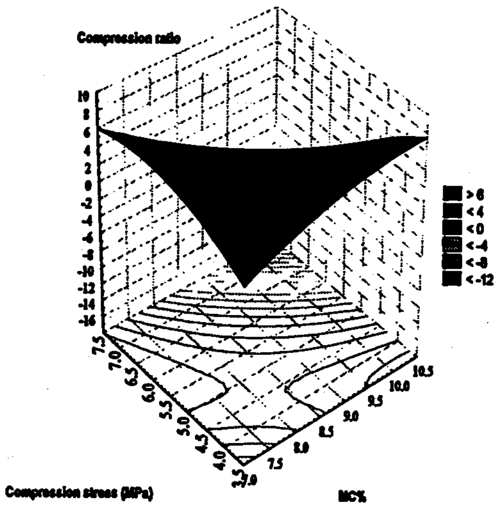
Fig. (7b) Effect of moisture content on compression stress and compression ratio for rice straw briquettes.

Compression ratio = 12.5982-2.2256*x+2.0061*y+0.161*x*x-0.1575*x*y-0.0767*y*
(7.4 ≤ x ≥10.35 %, 4.44 ≤ y ≥ 8.95 MPa)



Without binder

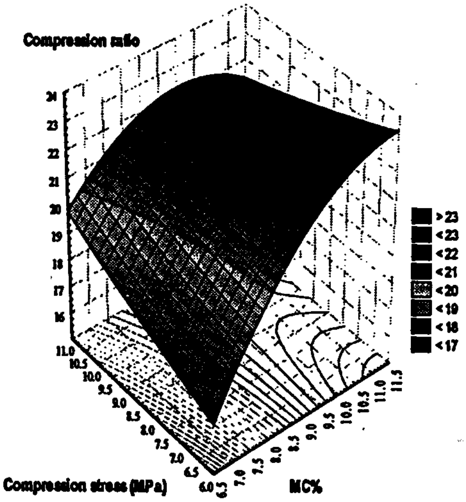
Compression ratio = -100.631+14.917*x+19.6151*y-0.4235*x*x-1.7128*x*y-0.6096*y*y
(7.4 ≤ x ≥10.35 %, 3.96 ≤ y ≥ 7.75 MPa)



With binder

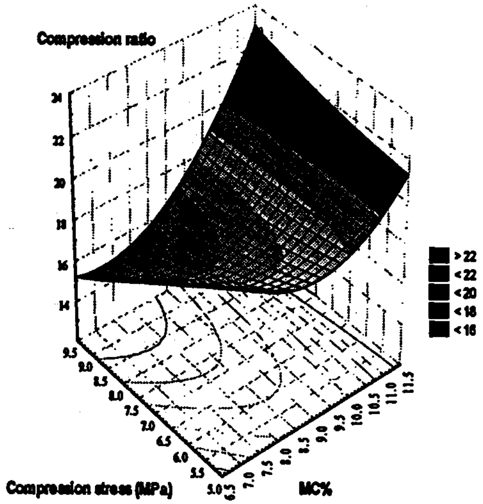
Fig.(7a) Effect of moisture content on compression stress and compression ratio for cotton stalks briquettes.

Compression ratio = -21.349+7.1761*x+1.6143*y-0.2583*x*x-0.2007*x*y+0.0163*y*y
(7.13 ≤ x ≥10.98 %, 6.97 ≤ y ≥ 10.39 MPa)



Without binder

Compression ratio = 74.7705-9.5309*x-4.4741*y+0.4299*x*x+0.3531*x*y+0.0549*y*y
(7.13 ≤ x ≥10.98 %, 5.58 ≤ y ≥ 8.92 MPa)

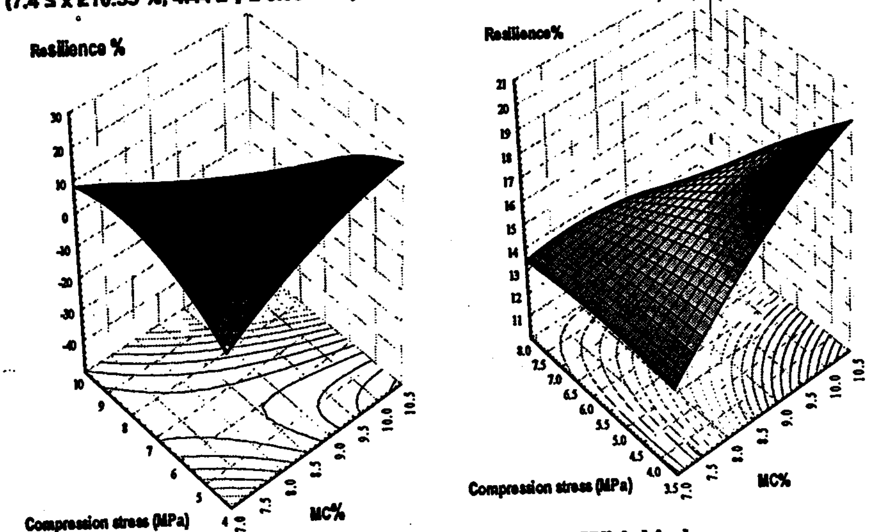


With binder

Fig. (7b) Effect of moisture content on compression stress and compression ratio for rice straw briquettes.

Resiliency% = -261.7925+39.5444*x+34.4434*y-1.2361*x*x-2.9141*x*y-0.8675*y*y
$(7.4 \le x \ge 10.35\ \%,\ 4.44 \le y \ge 8.95\ \text{MPa})$

Resiliency% = -27.5969+7.2333*x+3.8013*y-0.2189*x*x-0.4643*x*y-0.051*y*
$(7.4 \le x \ge 10.35\ \%,\ 3.96 \le y \ge 7.75\ \text{MPa})$



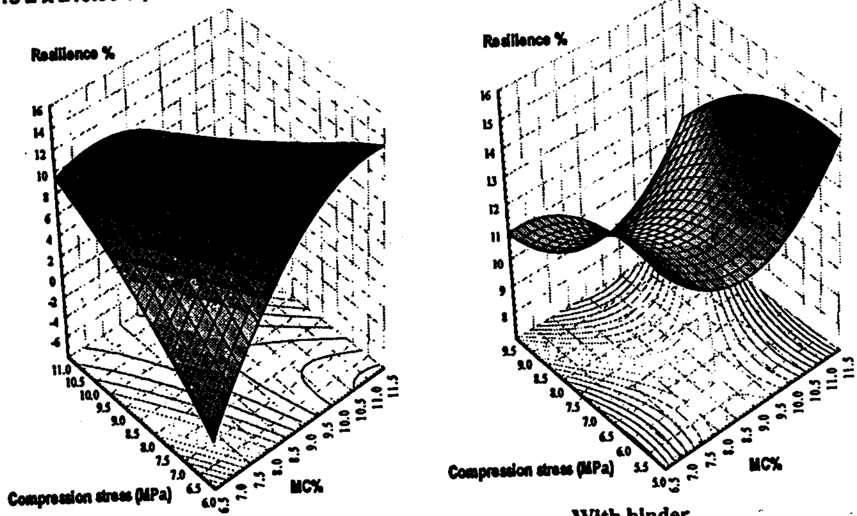
Without binder

With binder

Fig.(8a)Effect of moisture content on compression stress and resiliency for cotton stalks briquettes

Resiliency % = -155.2246+23.4389*x+13.6606*y-0.7622*x*x-1.0636*x*y-0.2461*y*y
$(7.13 \le x \ge 10.98\ \%,\ 6.97 \le y \ge 10.39\ \text{MPa})$

Resiliency % = 33.9821-6.8295*x+2.8177*y+0.3892*x*x-0.0072*x*y-0.2373*y*y
$(7.13 \le x \ge 10.98\ \%,\ 5.58 \le y \ge 8.92\ \text{MPa})$



Without binder

With binder

Fig.(8b) Effect of moisture content on compression stress and resiliency for rice straw briquettes

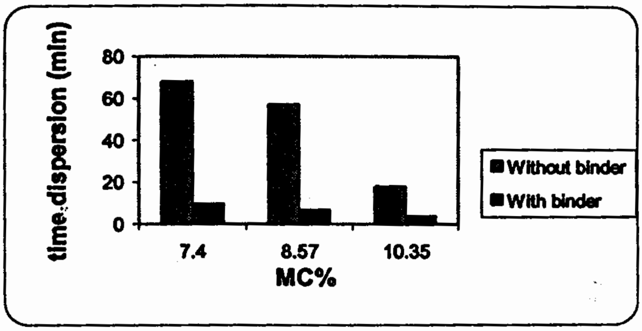


Fig (9a) the relation between moisture content and time dispersion for cotton stalks briquettes

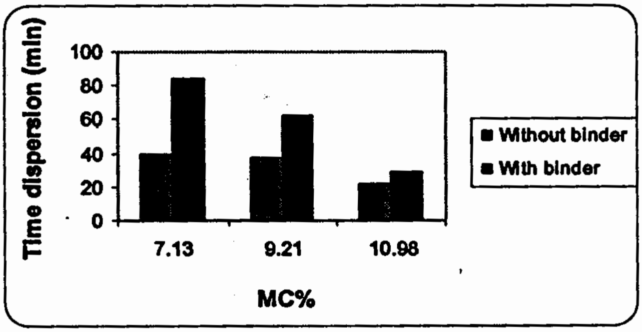


Fig (9b) the relation between moisture content and time dispersion for rice straw briquettes.

Effect of moisture content on gases emission of cotton stalk and rice straw

The relation between moisture content and gases emissions (CO, CO_2, NO_x and SO_2) for cotton stalks and rice straw (loose and briquettes) as shown in Fig. (4.8a and 4.8b). It can be noticed that, by increasing of moisture content the gases emissions increase. The gases emitted from cotton stalks and rice straw briquettes were less than stalks loose. Increasing of moisture content from 7.4 to 10.35 % the CO_2 emission increased from (2.2, 1.1and 1.6%) to (3, 1.6, and 2%) at cotton stalks (loose), cotton stalks briquettes without binder and with binder, respectively, the CO emission increased from (0.1197, 0.0098 and0.0175%) to (0.205, 0.015 and 0.0721%) at cotton stalks (loose) and cotton stalks briquettes without binder and with binder, respectively.

Increasing of moisture content from 7.13 to 10.98 % the CO_2 emission increased from (3.2, 0.9and 1.6%) to (4.7, 1.6, and 2.3%) at rice straw (loose), rice straw briquettes without binder and with binder, respectively, and the CO emission increased from (0.324, 0.0105 and 0.018%) to (0.5681, 0.018 and 0.032%) at rice straw (loose), rice straw briquettes without binder and with binder, respectively.

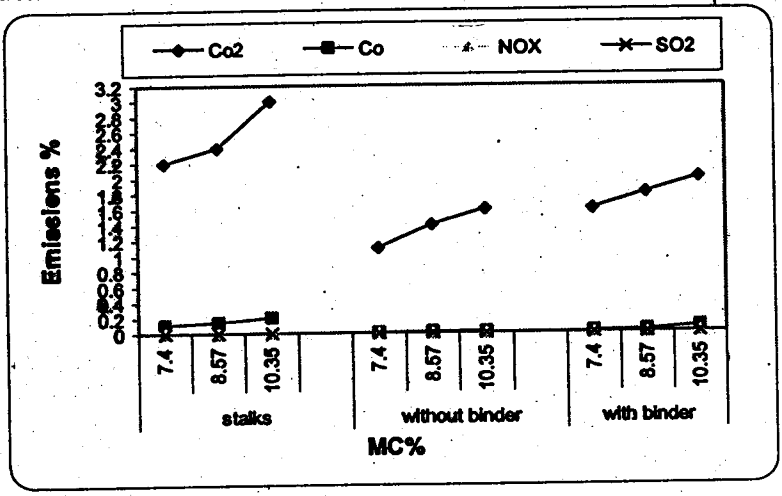


Fig. (4.8a). Effect of moisture content and binder (urea-formaldhyde) on gases emission for cotton stalks (loose and briquettes).

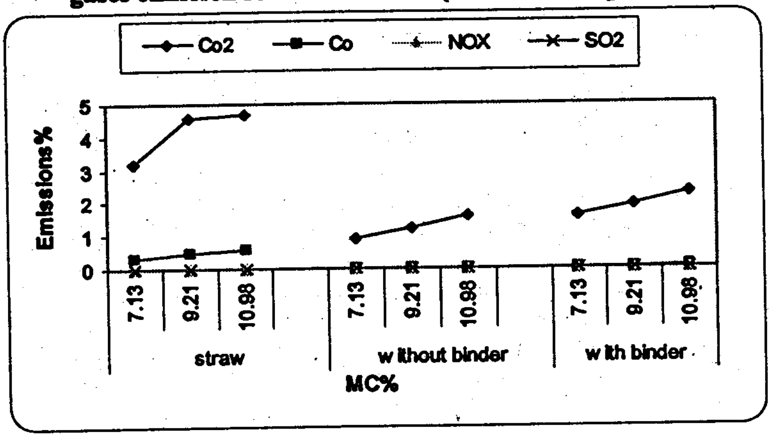


Fig. (4.8b). Effect of moisture content and binder (urea-formaldhyde) on gases emission for rice straw (loose and briquettes).

CONCULSION

Densification of biomass materials into briquettes could reduce costs and problems with handling, transportation, storage, and utilization of low bulk density biomass materials. And also, produce good quality (high strength and durability).

Moisture content of chopped residuals have a significant impact on the quality of the resulting briquettes the optimum quality properties of the briquettes were 7.4 and 7.13% moisture content of cotton stalks and rice straw, without binder, respectively. the highest compression stress, durability and bulk density were 8.95, 10.39 MPa, 97.06 %, 93.64 % and 1.18, 0.95 g.cm^{-3} for cotton stalks and rice straw briquettes, respectively Gases emission (CO_2 and CO) during combustion reduced from cotton stalks and rice straw briquettes without binder than the briquettes with binder and cotton stalks and rice straw (loose) at each moisture contents.

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الملخص العربي

خواص الجودة لقوالب حطب القطن وقش الارز

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فى الأونة الأخيرة أصبح إستخدام الطاقات الجديدة والمتجددة ضرورة ملحة نتيجة للنضوب السريع للطاقات التقليدية حيث أن الكتلة الحيوية تعتبرمن اكبر مصادر الطاقة الجديدة والمتجددة لتوافرها وإنخفاض أسعارها.

تعتبر المخلفات الزراعية النباتية والحيوانية منتجات ثانوية داخل منظومة الإنتاج الزراعى والتى تمثل مشكلة كبيرة للمزارعين وتؤثر بالسلب على البيئة المحيطة حيث يتم التخلص منها بطرق بدائية كالحرق أو التخزين مؤدية لزيادة التلوث. لذا يجب تعظيم الاستفادة منها بتحويلها إلى أسمدة عضوية أو أعلاف أو طاقة نظيفة أو تصنيعها مما يساهم فى الزراعة النظيفة وحماية البيئة من التلوث وتحسين الوضع الاقتصادى والبيئى. وينظر اليوم الى الكتلة الحيوية كمصدر من مصادر الطاقة الواعدة لتخفيف انبعاثات الغازات الدفينة (غازات الإحتباس الحرارى) يؤدى لتحسين الظروف الجوية المحيطة. وإستخدام الكتلة الحيوية كمصدر للطاقة يتم عن طريق مجموعة متنوعة من الطرق : كمادة وسيطة في الاحتراق المباشر في مواقد المنازل ومحطات الطاقة الحرارية ، والأفران والمراجل ، التغويز ، الانحلال الحراري والقولبه.

ويهدف هذا البحث الى دراسة تأثير المحتوى الرطوبى وإضافة المادة الرابطة لمخلفات حطب القطن وقش الارز المفرومه على خواص الجودة للقوالب الناتجة من كبسها فى مكبس مخروطى. وقد اجريت التجربة فى معمل الكتلة الحيوية بهيئة الطاقة الجديدة والمتجددة بمدينة نصر ومعمل مقاومة الخرسانة بكلية الهندسة جامعة المنوفية وقسم الهندسة الزراعية كلية الزراعة جامعة المنوفية فى عام ٢٠٠٩ , ٢٠١٠ حيث تم عمل الاتى:

- كبس المواد المفرومه من حطب القطن وقش الارز فى ماكينة كبس مخروطية مزودة بموتور قدرته ٣٠ كيلووات عند ضغط ١٠٠ ميجا بسكال ودرجة حرارة ١٦٠°م وذلك عند ثلاث محتويات رطوبة من حطب القطن (٨، ١٠ , ١٢ %) وقش الارز(٨، ١٠ , ١٢,٨%) وذلك بعدم إضافة رابط وبإضافة رابط (يوريافورمالدهيد) بنسبة ١٠% من كمية المادة المفرومة.

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- دراسة تأثير عملية الكبس على المحتوى الرطوبى للمواد المكبوسة.
- دراسة تأثير المحتوى الرطوبى و المادة الرابطة على بعض خواص الجودة للقوالب الناتجة مثل (إجهاد الضغط, الصلابة, المتانة, الرجوعية, الكثافة الظاهرية, نسبة الكبس وحجم الغازات المنبعثة منها مثل غاز أول وثانى اكسيد الكربون واكاسيد النيتروجين وثانى اكسيد الكبريت.

<u>وقد أوضحت الدراسة أنه.</u>

١- بعد عملية الكبس تقل نسبة الرطوبة للمواد المكبوسة من حطب القطن وقش الارز, حيث قلت نسبة الرطوبة من (٨ , ١٠ , ١٢ %) الى (٧,٤ , ٨,٥٧ , ١٠,٣٥%) ومن (٨ , ١٠ , ١٢,٨٠%) الى (٧,١٣ , ٩,٢١ , ١٠,٩٨%) على الترتيب.

٢- بزيادة المحتوى الرطوبى يقل اجهاد الضغط والمتانة والصلابة لقوالب حطب القطن وقش الارز حيث كانت افضل اجهاد ضغط ومتانة (٨,٩٥ و ١٠,٣٩ميجا بسكال) و(٩٧,٠٦ و ٩٣,٦٤ %) على الترتيب, لقوالب حطب القطن و قش الارز بدون إضافة رابط.

٣- أفضل كثافة للقوالب كانت ١,١٨ و ٠,٩٥ جم / سم٣ عند محتوى رطوبى ١٠,٣٥ , ١٠,٩٨ % لحطب القطن وقش الارز, على الترتيب, بدون إضافة رابط.

٤- أقل نسبة للغازات المنبعثة (أول وثانى أكسيد الكربون) كانت من القوالب الغير مضاف لها مادة رابطة عند كل محتويات الرطوبة للقالب لذلك توصى الدراسة بإستخدامها كوقود صديق للبيئة.