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EFFECT OF USING A NEW AUTOMATIC HEATING SYSTEM POWERED BY RENEWABLE ENERGY ON POULTRY HOUSES

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ABSTRACT: A new automatic simple heating technique was established to improve performance within poultry houses using renewable energy sources (Biogas energy). Four different heating systems were used in the work as follow: $H.S_1$; Conventional heating system using the cylinder of Liquefied Petroleum Gas LPG with open direct fire flame. $H.S_2$; Heating system using Biogas energy and the cylinder of LPG with open direct fire flame manual converting. $H.S_3$; Heating system using the cylinder of LPG with the automatic manufacturing heater and air distribution perforating tube. $H.S_4$; Heating system using Biogas energy and the cylinder of LPG with the automatic manufacturing heater and air distribution tube. The obtained results revealed that using Biogas increase poultry body weight/bird after 6 weeks by about 3%, and by about 4% approximately in total body weights, and increase production efficiency factor (PEF) by about 10.3% compared to conventional system. Also, applying $H.S_4$ increase poultry body weight/bird about 175 and 163% after first and second week respectively compared with the initial stage. In addition, increase the poultry weight/bird after 6 weeks by about 30%. Applying new system, also increase feed intake ranging about 6-8%, and decrease Feed conservation ratio ranging 29- 33%. Applying a new system and using biogas increasing the survival ratio by about 6%, sequent decrease mortality rate. In addition, increase PEF by about 85% comparing with conventional. Applying $H.S_4$ the total energy decreased by about 53%, Also the specific energy requirements (SER) highly improving where decreased by about 66% comparing with $H.S_1$.

Key words: Biogas, LPG, Automated heating system, Poultry houses.

INTRODUCTION

Agriculture is one of the major sectors for any country economy, which contributes high percent in its GDP "Gross Domestic Product" (**Yuanlong *et al.,* 2020**). The poultry industry not only supplies animal protein for feeding the human population, but also linked to other industries such as; animal feed, medicine and veterinary inputs (**Dinodiya *et al.,* 2015**). The poultry industry is one of the main agricultural industries in Egypt. The efficiency of traditional agricultural practices must be raised to improve agricultural productivity, especially poultry and animal's productivity environmental sustainability (**Lambin and Meyfroidt, 2011**). The poultry industry plays an important role in the economy of Iran because a huge consumption of chicken is demand (**Stives, 2018**). Modern forms of agriculture must include solutions to low agricultural productivity, depleted poultry reserves, and limited animals feed availability, as well as help in meeting the challenges of agricultural productivity (**Humbert *et al.,* 2007**). Heating within poultry houses is a critical part of the process to ensure bird health, maximum chicken growth and minimum energy consumption. Moreover, the cost of heating a poultry hold represents a significant proportion of the total poultry-hold energy cost. A wide range of technologies is available for heating in poultry holds. There are a number of advantages and disadvantages to each type of equipment,

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heat output, heat distribution and unit distribution/placement (**Czarick, 2008**). Heater selection is critical to maximizing poultry-hold energy efficiency (**Czarick, 2005**). At present, broiler houses in some places are equipped with direct gas heating systems, which consist of open gas burners and a fan that blows heat from the flame directly into the broiler house. These direct heaters produce high concentrations of carbon dioxide (CO_2) and moisture. Indirect systems heat and transfer air into houses without additional CO_2 and water vapor. As a result, manufacturers claim indirect heating systems could improve environmental conditions by reducing CO_2 concentrations, moisture and ammonia within broiler houses when compared with direct heating systems (**Zhang e*t al.*, 2020**). Although tunnel ventilation works effectively to improve bird comfort and growth performance during hot weatherbut, it is not intended for cold weather ventilation. During cold weather when the ventilation rate is reduced to the minimum, tunnel ventilation can work against you by generating large end-to-end differences in air temperature, humidity and aerial contaminants such as ammonia and dust (**Wu *et al.*, 2020**). The conventional heating process in poultry houses depends on burning of fossil fuel. Old system fashion used fossil fuel. Fossil fuel produce a large amounts of carbon dioxide (CO_2) emission and pollution occurred. This system has a negative effect on organisms. Addition to high price, and infrequency of fossil fuel now. Therefore, increasing in producing renewable energy to become very necessary (**Morsheck *et al.*, 2020**). Renewable energy has many benefits such as environmental benefits, economic benefits, energy security and the vital source of energy for future generations. In the same time the poultry industry plays an important role in the economy of Iran because a huge consumption of chicken is demand. One of the most important sections in agriculture that have high-energy consumption is poultry industry. Heating the poultry house can reduced by renewable energy (**Stives, 2018**).

Nowadays production of renewable energy such as biogas become very important. Many types of organic matters considered as substrates for biogas production as organic municipal waste, manure, sewage sludge and agricultural wastes (**Appels *et al.*, 2011**). Also fermentation of organic wastes can be supplies farms a lot amount of renewable energy (biogas). Biogas energy has many usages in agricultural applications (**Abd Allah *et al.*, 2021**). Hot air systems are well established and they have domestic and commercial applications. These systems use biogas energy to generate hot water and hot air (**Nassour, 2013**). Energy is a fundamental requirement for man's comfort and basic needs of everyday life. The great majority of nations, particularly developing nations, are experiencing energy crises due to an overreliance on fossil fuels (**Mohamed *et al.*, 2021; Gursan and Gooyet 2021**).

Energy security, environmental protection, and economic growth are the three main national energy drivers of all nations worldwide. The need for alternative energy sources arises from predictions that fossil fuels such as coal, gas, and oil will run out within the next 10 decades (**Azam, 2021**). Biogas, biomass, and biofuel are all renewable energy sources existing in different phases of the transformation. Cattle manure, agricultural crop wastes, and other biomass can be convert into biogas through controlled anaerobic degradation (**Pasternak, 2021; Abd Allah *et al.*, 2022**).

Implementing biogas improves to the environmental sustainability of the energy transition by decreasing global greenhouse gas emissions and consequently the global warming. Biogas is an adaptable fuel because it emits low amounts of greenhouse gases, can produced from renewable energy, may be used to treat organic waste before it is disposed of kill pathogens in biomass and has a wide range of energy uses. Due to the plentiful supply of inexpensive feedstock and the availability of a variety of biogas applications in heating, power generation, fuel, and raw materials for further processing and production of sustainable chemicals, including hydrogen, carbon dioxide, and biofuels, biogas is a competitive, viable, and generally sustainable energy resource (**Kabeyi *et al.*, 2022**).

Methane composition, which is affected by the procedure and the kind of substrate utilized in its production, determines the energy content of biogas. The methane content in biogas affects its calorific value, which varies with composition (**Prussi *et al.,* 2019**). To reduce environmental deterioration and greenhouse gas emissions, it is necessary to conserve the environment and dispose of waste in an environmentally responsible way. Worldwide, the use of renewable energies has become an attractive and alternative energy system due to the rising expense of fossil fuels and the increased pollution caused by their combustion (**Sahito *et al.,* 2014**).

In order to reduce energy consumption in poultry farming, there has been extensive research and application of renewable and sustainable energy technologies. The main technologies include photovoltaic (PV), solar collector, hybrid PV/Thermal, thermal energy storage, ground/water/air sources heat pumps, lighting, and radiant heating. When compared to conventional poultry buildings, it has been discovered that employing these cutting-edge technology can save up to 85% more energy over a period of 3 to 8 years (**Cui *et al.,* 2020**). Assessment of the three different resources of energy; LPG, biogas, and electricity (lighting) used to warm poultry sheds, the warming by lighting recorded internal humidity lower than the warming by biogas and LPG, while the LPG recorded the largest value of humidity. Biogas energy may be a feasible nontraditional resource for warming poultry houses especially if the organic wastes were available free at the same farm (**Ebrahem *et al.,* 2022**).To encourage the use of new and renewable energy sources and to maximize the use of agricultural biomass, in addition to avoiding direct firing inside the poultry houses and saving energy through automatic temperature control, which is reflected in energy savings, this work was carried out. The new automatic heating system powered by renewable energy sources (Biogas energy), the first used warming technique for broiler sheds,

Hence, the objectives of this study are:

1- Manufacturing an automatic heating system for poultry farms using renewable energy sources (Biogas).
2- Performance evaluation of the automatic heating system for poultry farms using renewable energy sources (Biogas).

MATERIALS AND METHODS

The present study was conducted under uncontrolled environmental conditions in broiler houses located in the poultry farm in Kafr Saqr district, Sharkia Governorate, Egypt, to evaluate the performance new heating system for poultry farms using biogas as a renewable energy sources compared to conventional method. An experiment was carried out through two successive winter seasons (December- February) of 2017/2018 and 2018/2019. Chinese Biogas plant was constructing, testing and operating to produce Biogas as a renewable energy sources to use for heating poultry houses.

Experimental Design (Experimental Procedure)

Four experimental groups were carrying out at the poultry farm to evaluate the four different heating systems Fig. 1 within poultry houses. The four different heating systems were as follow

1- $H.S_1$; Conventional heating system using fossil fuel source (the cylinder of Liquefied Petroleum Gas LPG) with open direct fire flame.
2- $H.S_2$: Heating system using Biogas energy and the cylinder of Liquefied Petroleum Gas LPG with open direct fire flame manual converting)
3- $H.S_3$: Heating system using the cylinder of Liquefied Petroleum Gas LP G with the automatic manufacturing heater and air distribution perforated tube.
4- $H.S_4$: Heating system using Biogas energy and the cylinder of Liquefied Petroleum Gas LPG with the automatic manufacturing heater and air distribution perforated tube.

All other traditional practices for poultry breeding were applied for all young and old chicken were applied, like ventilation, health care, feeding, drinking, and vaccinate recommended. All experiments were carried out every week from 2 to 6 weeks of age. Sufficient samples were taken to determine the all-experimental measurements. The poultry houses were prepared with optimum environmental conditions are (Air velocity was 2 $m.s^{-1}$- Ambient temperature (variable according age of broiler, starting degree was about 32°C, then decrease 2 °C weekly).

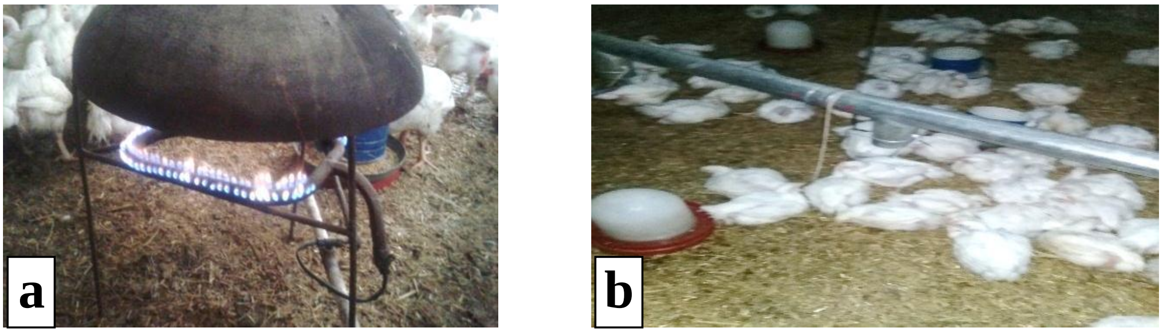

Fig. 1. Photos of heating system components inside the shed: a) Open direct fire flame, b) Air distribution perforated metal tube

Materials

Shed Characteristics

The poultry shed consists of four groups, each one consider as one house with area about 40 m^2 has 400 birds for each, and stocking capacity 10 bird.m^{-1}.

Chinese Biogas Plant

Chinese Biogas plant was constructing according previous research recommendation to produce biogas using as a new energy source to heating poultry houses. Basic components of the Chinese biogas model Fig. 2 and Table 1.

The new automatic manufacturing heater

The new automatic manufacturing heater shown in Fig. 3 can use a fossil fuel (LPG) and Biogas energy which produce from digester, using alternative device. The new heater contains separating chamber "attached chamber" have broiler used to heating air inside closed pipes-Metal pipes and some valves, used to transfer hot air from heating zone to inside poultry house. The heater was constructed from local material witch available in the Egyptian market. About 10% of the components are imported and available in the market, is consisted of four standard gas burners, 60 cm length, contained in an insulated steel cylinder, 40 cm diameter and 90 cm length. The cylinder has bottom holes to allow the fresh air in and a chimney to discharge the exhaust gases. An eccentric 10 cm diameter stainless tube, 2 mm thickness and 110 cm length, is passing through the upper part of the insulated cylinder to carry the air to be heated. The heater is equipped with a pilot light to keep the fire on during heat shut down according to the sensors signals. The unit has a 20 cm diameter air blower operated by a 2-phase electric motor, rated power is 0.25 kW. (Table 2). It was controlled in the hot air flow rate through the system, the blower flow rate. Thus, a speed controller is used to reduce the blower air speed. This heater is operated using many different energy sources from LPG, new and renewable sources (Biogas). The air is heated by two sources of energy, one of which is LPG and Biogas. Three solenoid valves were connected to the gas inlet to allow switching between LPG and Biogas according to a signal from the thermostat **(Abd-Allah *et al.*, 2022).**

The three electric valves (Selnoid valves), all of which are installed on the heater outside the shed, and each of them is connected to a thermal thermostat inside the shed, through which the heater is turned on and off, as well as switching between the gas produced from the Chinese biogas plant and liquefied gas automatically, according to the optimal temperature required for the bird.

A line of metal tubes connected to the heater inside the shed. Air distribution perforated tube It has four openings, each with a distance of 90 cm. A pipe is installed on each of them heading towards the floor of the shed. At the end of each of them is a metal valve whose opening and closing are controlled manually to control the space of the shed according to the age stage, so that all openings are open at the end of the fattening cycle.

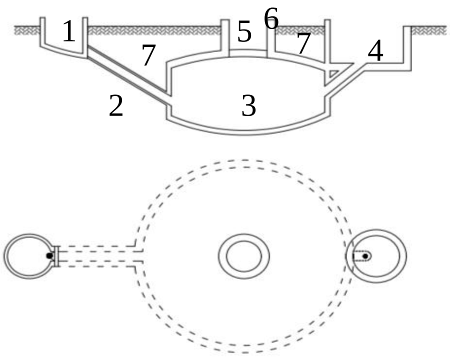

Fig. 1. Chinese biogas digester model

Table 1. Basic components of the Chinese biogas model

Part	Name
1	Mixing Pit or Inlet
2	Inlet pipe
3	Digester/Gas Storage
4	Outlet Chamber
5	Removable Manhole
6	Gas Outlet Pipe
7	Backfill

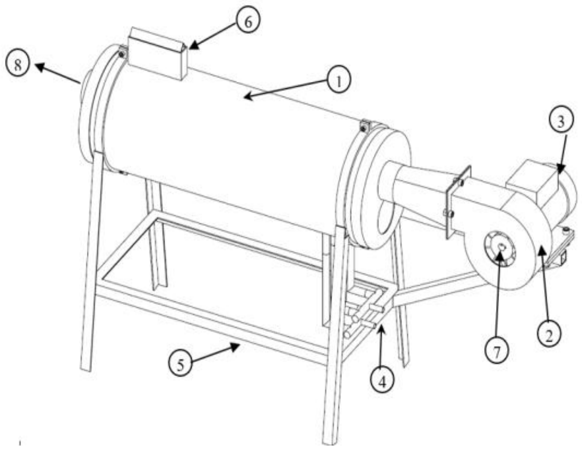

Fig. 2. A new automatic manufacturing heater presented by (Abd-Allah *et al.*, 2022)

Table 2. Basic components of a new automatic manufacturing heater

Part	Name
1	Insulated galvanized cylinder
2	Air blower
3	Electric motor
4	Gas burner
5	Frame
6	Chimney
7	Air inlet
8	Hot air outlet

Measurements

Body weight

At the end of each experiment 5% of birds weighed as group. The total weight is divided by the number of weighed birds.

Feed intake (FI)

$$\text{FI} = \frac{\text{Total consumed feed}}{\text{No. of birds}}$$

Feed conversion ratio (FCR)

$$FCR = \frac{\text{Feed intake, Kg}}{\text{Body weight gain, Kg}}$$

(**Wagne e*t al*., 1983**).

Mortality percent (%)

$$\text{Mortality percent (\%)} = \frac{\text{Number of dead birds}}{\text{Total number of birds.}} \text{x}100$$

(**Halpin, 1975**).

Survival rate: =

$$\frac{\text{Total no. of birds} - \text{No. of dead birds}}{\text{Total no.of birds}} \times 100$$

Production efficiency factor (PEF)

It was calculated according to **Samarakoon and Samarasinghe (2012)**

$$\text{PEF} = \frac{\text{Body weight gain (kg)} \times \text{survival rate (\%)}}{\text{Age of depletion (day)} \times \text{FCR}} \times 100$$

Total heat energy

kJ = Amount of fuel consumption, kg * Fuel calorific value, kJ. Kg^{-1}

The calorific values of 50 and 40 MJ. Kg^{-1} for LPG and Biogas respectively.

Specific energy requirements (SER)

$$\text{SER} = \frac{\text{Total heat energy ,MJ}}{\text{Total poultries body ,kg}}$$

(**Ali *et al*., 2011**)

RESULTS AND DISCUSSIONS

Effect of Heating System on Poultry Body Weight

From Fig. 4, it is evident obviously, that the applying a new system and using biogas improve the environmental conditions inside the poultry houses. Moreover improving in all biological factors, ventilation rate enhance ameliorate chicken health within poultry houses. In addition, the final improving poultry body weight at different poultry ages. Applying new system $H.S_4$ increasing body weight ranging by (155 – 175%) after first and second weeks compared to initial stage. While these increasing become to decrease gradually after that. After 6^{th} week, the total poultry body weight increase by about 30.6, 31.01, 32.33, and 32.55% for the 4 different heating systems respectively compared to initial stage. Also using biogas in HS_2 and HS_4 increase poultry body weight/bird ranging about (3-4%) approx. compared to conventional system, and by about 4% approximately in total body weights for the same treatments equal.

Effect of Heating System on Poultry Feed Intake (FI)

Feed intake consider one of many factors used for evaluate performance of broilers. Data in Fig. 5 depict that, the applying new system increasing the feed intake after first week by more than 6 and 8% for $H.S_3$ and $H.S_4$ treatment respectively compared to conventional treatment. While these increasing were equals for the same treatments, and was about 4% after second week. After 6^{th} week FI increased by about 6&8% due to applying new system, and using renewable energy (biogas). On the other side using renewable energy (biogas) the FI increase by about 1% in the first, and second weeks, and increased ranging about (0.5-2%) after 6^{th} week. This means that the using biogas and applied new system for heating poultry houses help to ameliorating the biological and physiological conditions. Sequentially the total amount of feed consumption highly increased with different chicken ages. Due to the same previous reasons mention above.

Effect of Heating Systems on Poultry Feed Conversion Ratio (FCR)

This property can be defined as the possibility of bird on transformation feed to bird body weight gain.This can be occured due to the optimum environmental climate and the good health of bird, which obtained by applying new technique heating system. When FCR decreased the feed intake increased. This means improving in bird body weight gained due to good bird healthing. The values of FCR were 2.65, 2.5, 2.06 and 1.99 for $H.S_1$, $H.S_2$, $H.S_3$ and $H.S_4$, respectively (Fig. 6). The feed conservation ratio (FCR), decreased by about 29 and 33% when applied new technique heating system under $H.S_3$ and $H.S_4$ treatments respectively compared with $H.S_1$ treatment. These due to the reasons mention in the above (first paragraph).

Effect of Heating Systems on Mortality and Survival Rates

From Figs. 7 and 8, it is evident obviously that is the applying the new heating system and using methane (renewable energy) help to highly increase survival rate and sequent decrease mortality rate. This occurs due to using a new heating system (methane) helps to ameliorating all situations, physiological and biological conditions within poultry houses. This due to the negative and significant effects on carbon dioxide (CO_2) emission, which indicates that CO_2 emission can be reduced by using methane ($H.S_2$ compared to $H.S_1$), and applying new heating system ($H.S_3$ and $H.S_4$ compared to $H.S_1$ $H.S_2$).Addition to improving all biological reactions. Therefore, best bird body weight and good health for bird at all different ages.

The survival rates were 98% for both of $H.S_3$ and $H.S_4$. While they were 92 and 93% for $H.S_1$ and $H.S_2$, respectively. Mortality rate were 8, 7, 2 and 2% under treatments $H.S_1$, $H.S_2$, $H.S_3$ and $H.S_4$ respectively. Applying new technique heating system in $H.S_3$ and $H.S_4$ improving survival rates more than 6% comparing with conventional system (old system) in $H.S_1$.

Effect of Heating System on Production Efficiency Factor (PEF)

The production efficiency factor value (PEF) is used to measure the technical performance of a broiler taking into account feed conversation ratio, live ability, body weight and age at depletion. The increasing of the PEF value means improving performance rate for broiler.

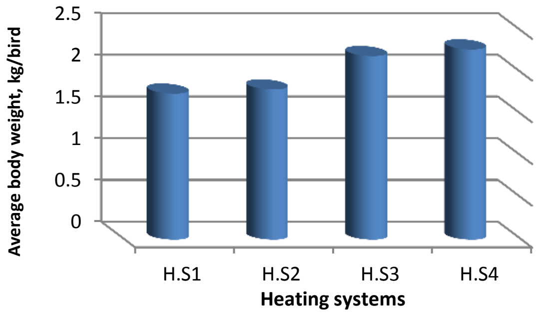

Fig. 4. Effect of heating systems on average poultry body weight

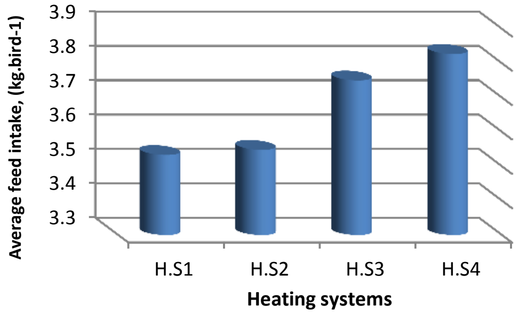

Fig. 5. Effect of heating systems on average feed intake

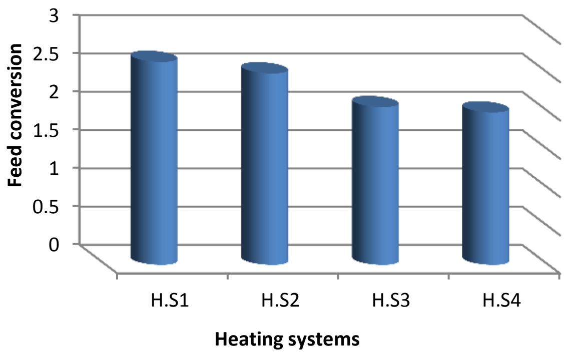

Fig. 6. Effect of heating systems on feed conversion

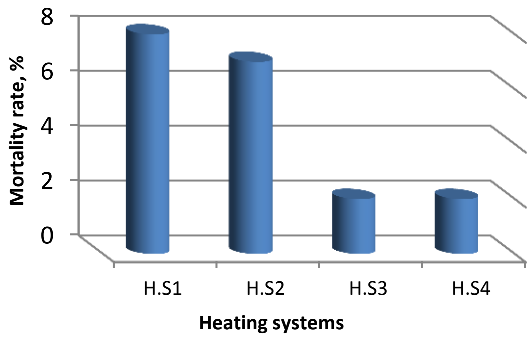

Fig. 7. Effect of heating systems on the mortality rate

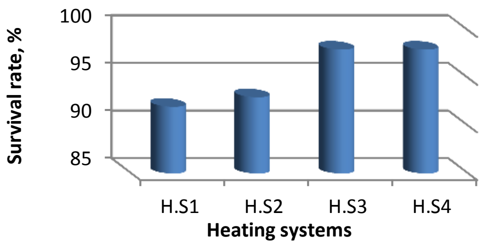

Fig. 8. Effect of heating systems on the survival rate

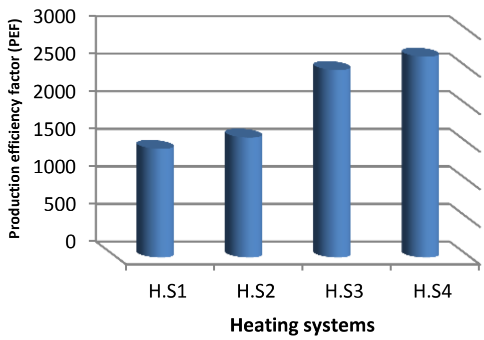

Fig. 9. Effect of heating systems on production efficiency factor

$H.S_1$; Conventional heating system using the cylinder of Liquefied Petroleum Gas LPG with open direct fire flame .

$H.S_2$; Heating system using Biogas energy and the cylinder of Liquefied Petroleum Gas LPG with open direct fire flame manual converting.

$H.S_3$; Heating system using the cylinder of Liquefied Petroleum Gas LP G with the automatic manufacturing heater and air distribution perforated tube.

$H.S_4$; Heating system using Biogas energy and the cylinder of Liquefied Petroleum Gas LPG with the automatic manufacturing heater and air distribution perforated tube.

These due to using the new heating technique system and biogas helping to ameliorate performance rate for broiler as a result of improving the environmental conditions inside the poultry houses (favorable climates). which decreased the percentage of gas emission. Moreover improving in all biological and physiological factors.

Using biogas (part – time) as in $H.S_2$ increase PEF by about 10.3%, compared to conventional system. While applying the new heating technique system and using biogas (part – time) as in $H.S_4$ increase PEF by about 85%, compared to conventional system. On the other side under $H.S_3$ (applying the new heating technique system and using LP gas, increase PEF by about 73% compared with $H.S_1$ too (Table 3).

Fuel Consumption

Effect of heating system on fuel consumption

Heating in poultries houses depend on burning of fuel. Old system fashion used fossil fuel. Fossil fuel and old system (conventional method) produce large amounts of gases emission and pollution occurs. They have a negative effect on organisms. Addition to high price, and infrequency of fossil fuel now. Therefore, increasing in producing renewable energy to become very necessary.

Table 3 show the amounts of fuel using for heating poultry houses. It is evident obviously that the, applying new heating system highly decrease in fuel consumption. This due to large amount of fuel leakage through opened flame, connection pipes, elbows and joints in conventional method, also increasing pollution inside poultry houses, and the final high production costs will expected. Applying new technique system for heating poultry houses highly saved the fuel consumption. Total fuel consumption was 112.18 kg for treatment $H.S_4$, whereas was 218.545 kg for treatment $H.S_2$. This means applying new technique system for heating poultry houses saved fuel consumption by about 95%. Where the total fuel consumption was 96.81kg for treatment $H.S_3$. While was 205.45 kg for treatment $H.S_1$. In this case the new heating system saved consumption fuel by about 112 %. The fuel consumption in treatment $H.S_4$ (112.18 kg). was greater than treatment $H.S_3$ (96.81kg). This difference due to difference between calorific values for LPG and product gas (biogas).

Specific energy requirements (SER)

Specific energy is the amount of energy required for drying or preparing 1kg of fresh product **(Ali *et al.*, 2011).** When the specific energy requirements (SER) decreased, it means increasing in total product, or decreasing in total required energy). Table 3 and Fig. 10 illustrates, when using new heating technique system the SER highly decreased. They were11.227 and 10.878 $kJ.kg^{-1}$ for treatments $H.S_3$ and $H.S_4$, respectively. In same time they were 31.904 and30.771 $kJ.kg^{-1}$ for treatments $H.S_1$ and $H.S_2$ respectively. This due to highly decreasing in total required of heat energy, and increasing in total poultry bodies (total product). Also Table 2 and Fig. 10 show that the, although the total required of heat energy was greater under $H.S_2$ (10.302 kJ) compared with $H.S_1$ (10.272 kJ). But the specific energy requirements (SER) was contrary to this. Where SER were 30.771 and 31.904 $kJ.kg^{-1}$ for the two treatments respectively. This due to high increasing in total poultry body in $H.S_2$ than $H.S_1$, resultant the same previous mention in the above paragraph. The same observation was noticed under $H.S_4$ and $H.S_3$. Where the total required of heat energy were 4861 and 4841 kJ, while SER were 10.878 and 11.227 $kJ.kg^{-1}$ for the two treatments respectively, the results of this study are similar to these several authors in the introduction.

Conclusions

From the obtained results, it can be concluded that to improve overall poultry performance must be applied the new automatic heating system ($H.S_4$) to maximize the different parameters of poultry production and decrease specific energy requirements.

The authors recommended increasing the use of renewable energy instead of fossil fuel and collecting all kinds of agricultural residues for producing different sources and forms of biofuels by the different conversion techniques to use in different agricultural applications.

Table 3. Effect of different heating systems on some studying parameters, total fuel consumption and total consumed heat energy

Heating systems	TNLB*, bird	TPBW, kg	TCF, kg	TFC, kg	TCHE* (MJ)
$H.S_1$	184	322	650	205.45	10.273
$H.S_2$	186	334.8	660	218.54	10.302
$H.S_3$	196	431.2	735	96.81	4.841
$H.S_4$	196	446.88	750	112.18	4.861

*Start number of birds on the first day was 200 birds. TNLB; Total Number of live birds – TPBW; Total poultry body weight – TCF; Total consumption feed – TFC, Total fuel consumption - TCHE; total consumed heat energy

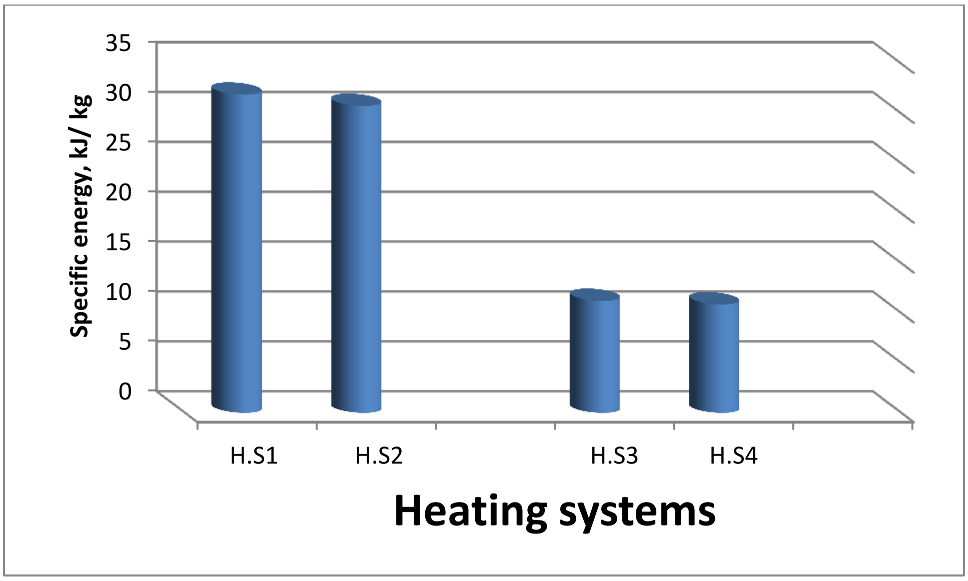

Fig.10. Effect of heating systems on specific energy.

$H.S_1$; Conventional heating system using the cylinder of Liquefied Petroleum Gas LPG with open direct fire flame .
$H.S_2$; Heating system using Biogas energy and the cylinder of Liquefied Petroleum Gas LPG with open direct fire flame manual converting.
$H.S_3$; Heating system using the cylinder of Liquefied Petroleum Gas LP G with the automatic manufacturing heater and air distribution perforated tube.
$H.S_4$; Heating system using Biogas energy and the cylinder of Liquefied Petroleum Gas LPG with the automatic manufacturing heater and air distribution perforated tube.

REFERENCES

Abd Allah, W.E., M.A. Tawfik, A.A. Sagade, S. Gorjian, K.A. Metwally and H. El-Shal (2021). Methane production enhancement of a family-scale biogas digester using cattle manure and corn stover under cold climates. Sustainable Energy Technol. and Assessments, 45: 101163.

Abd-Allah, Y.S., T.H. Ahmed and K.A. Metwally (2022). Evaluation of The Drying Process of Paddy Rice with a Biogas Continuous Rotary Dryer. Misr. J. Agric. Eng., 40 (1): 59-74.

Ali, M., M. Saeid, H.K. Mohammad and A. Hamed (2011). Comparison of energy consumption and specific energy requirements of different methods for drying mushroom slices. J. Food Eng., 36: 6433 - 6441.

Appels, L., J. Lauwers, J. Degrève, L. Helsen, B. Lievens, K. Willems and R. Dewil (2011). Anaerobic digestion in global bio-energy production: potential and research challenges. Renew. Sust. Energ. Rev., 15 (9):4295–4301.

Azam, A., M. Rafiq, M. Shafique and J. Yuan (2021). Renewable electricity generation and economic growth nexus in developing countries: An ARDL approach. Economic Research-Ekonomska Istraživanja, 34 (1): 2423-2446.

Cui, Y., E. Theo, T. Gurler, Y. Su and R. Saffa (2020). A comprehensive review on renewable and sustainable heating systems for poultry farming. Int. J. Low-Carbon Technol., 15 (1): 121-142.

Czarick, M.F.B. (2005). The best way to cut heat costs is not to change your heating system. Poult. Environ. and Energy Conserv. Poult. Housing Tips, 17: 13.

Czarick, M.D.D.F.B. (2008). Alternative heating systems: an overview. Poult. Environ. and Energy Conserv. Poult. Housing Tips, 20: 14.

Dinodiya, J., A.K. Jhirwal, R.S. Choudhary, S.C. Goswami, V.K. Choudhary, V. Mahla, J.S. Saharan and R. Charan (2015). Broiler performance of cobb 400 chicks with herbal versus synthetic antimicrobial feed supplements in diet. Anim. Sci. Rep., 9 (1): 16-21.

Ebrahem, M.E., M.M. Moustafa and A. El-Salam (2022). Biogas utilization system for warming poultry houses. Misr. J. Agric. Eng., 39 (2): 341-352.

Farghly, M.F.A., K.M. Mahrose, R.G. Cooper, K.A. Metwally, M.S. Abougabal and I.T. El-Ratel (2021). Use of available crop by-products as alternative bedding materials to wheat straw for rearing broilers. Anim., 15 (7): 100260.

Gürsan, C. and V. de Gooyert (2021). The systemic impact of a transition fuel: Does natural gas help or hinder the energy transition. Renewable and Sustainable Energy Rev., 138: 110552.

Haplin, B. (1975). Patterns of animal diseases 1st Ed. Vet. Pathol., 32: 235-239.

Hassan, M., S.M. Aboelenin, M.M. Soliman, H.F. Attia, K.A. Metwally, H.M. Salem and R. Khalaphallah (2022). Biogas manufacture from co-digestion of untreated primary sludge with raw chicken manure under anaerobic mesophilic environmental conditions. Saudi J. Biol. Sci., 29 (4): 2969-2977.

Humbert, L.D.G., D. Kneeshow and C. Messier, 2007. A shade tolerance index for common understory species of northeastern North America. Ecol. Ind., 7 (1): 195–207.

Kabeyi, M.J.B. and A.O. Oludolapo (2020). Optimization of biogas production for optimal abattoir waste treatment with bio-methanation as solution to Nairobi slaughterhouses waste disposal. In 2nd Afr. Int. Conf. on Industrial Eng. and Operations Manag., Harare, Zimbabwe, 5-7.

Lambin, E.F. and P. Meyfroidt (2011). Global land use change, economic globalization, and the looming land scarcity. Proc. Natl. Acad. Sci., USA. 108, 3465–3472. https://do i.org/ 10.1073/pnas.1100480108.

Mohammad, N., W.W. Mohamad Ishak, S.I. Mustapa and B.V. Ayodele (2021). Natural Gas as a Key Alternative Energy Source in Sustainable Renewable Energy Transition: A Mini Review. Frontiers in Energy Res., 237.

Morsheck, L., J. Baeyens, J. Degre`ve and R. Dewil (2020). Principles and potential of the anaerobic digestion of waste-activated sludge. Prog. in Energy and Comb. Sci., 43 : 755–781.

Nassour, A.G. (2013). Use of Biogas Energy in Poultry Farming Heating. J. Agric. Eng. and Biotechnol. Aug., 1 (2): 30-36.

Oladimeji, A.M., T.G. Johnson, K. Metwally, M. Farghly and K.M. Mahrose (2022). Environmental heat stress in rabbits: Implications and ameliorations. Int. J. Biometeorol., 66 (1): 1-11.

Pasternak, G. (2021). Electrochemical approach for biogas upgrading. In Emerging Technologies and Biological Systems for Biogas Upgrading. Academic Press, 223-254.

Prussi, M., M. Padella, M. Conton, E.D. Postma and L. Lonza (2019). Review of technologies for biomethane production and assessment of Eu transport share in 2030. J. Cleaner Prod., 222: 565-572.

Reece, J.D. and B.D.J.D. Lott (1998). Air velocity and high temperature effects on broiler performance. Poult. Sci., 77:391–393.

Sahito, A.R., R.B. Mahar and F. Ahmed (2014). Effect of buffalo dung to the water ratio on production of methane through anaerobic digestion. Mehran Univ. Res. J. Eng. Technol., 33: 237–244

Samarakoon, S.M. and K. Samarasinghe (2012). Strategies to Improve the Cost Effectiveness of Broiler Production. Tropical Agric. Res., 23 (4): 338– 346.

Stives, N.O. (2018). Forecasting-the-Thermal-Load-for-Implementing-Solar-Energy-in-a-Model-Poultry-House. . J. Poult. Sci., 17 (8): 720-728.

Wagner, D.D., R.D. Furrow and B.D. Bradely (1983). Sub chronic toxicity of growth promoters in broiler chickens. Vet. Pathol., 20: 353-359.

Wu, X., W. Yao, J. Zhu and C. Miller (2020). Biogas and CH4 productivity by co-digesting swine manure with three crop residues as an external carbon source. Bioresour. Technol., 101: 4042–4047.

Yuanlong, C., E. Theo, T. Gurler, Y. Su and R. Saffa (2020). A comprehensive review on renewable and sustainable heating systems for poultry farming. Int. J. Low-Carbon Technol., 15 (1): 121–142.

Zhang, Y., E.M.Z. Cañas, Z. Zhu, J.L. Linville, S. Chen and Q. He (2020). Robustness of archaeal populations in anaerobic co-digestion of dairy and poultry wastes. Bioresour. Technol., 110 (2): 779–785.

تأثيــر إســتخـدام نظام تدفئة جديد أتوماتيكى يعمل بالطاقة المتجددة على عنــابــر الدواجــن

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تهدف هذه الدراسة الي إيجاد حلول لبعض المشاكل الهندسية في عنابر الدواجن. لذا تم تجميع نظام تدفئة لتحسين الأداء داخل هذه العنابر، وذلك لتدفئة الوسط المحيط داخل العنابر ومحاولة استخدام مصادر الطاقة الجديدة والمتجددة. هذا النظام الجديد يعتمد علي تسخين الهواء الجوي في سخان منفصل خارج عنبر الدواجن ثم دفع الهواء الساخن بواسطة مروحة إلي داخل العنبر خلال انابيب معدنية مثقبة. وهو نظام يستخدم لأول مرة فى تدفئة عنابر دواجن التسمين، تم مقارنته بالنظام التقليدي القديم والذي يستخدم الوقود الاحفوري ونظام الشعلة المفتوحة والتي توقد داخل العنبر فتلوث الوسط المحيط مما يؤدى إلي تأثير سالب على الدواجن. ولتوفير الغاز الحيوى (البيوجاز) أحد صور الطاقة الجديدة والمتجددة وللمقارنة بين النظام الجديد والأنظمة الأخرى تم اختيار أربعة نظم مختلفة للتدفئة كالتالى نظام التدفئة الأول وهو التقليدي بإستخدام مصدر الوقود الاحفوري (الغاز البترولى المسال اسطوانة الغاز التجارية 25كجم، غاز البروبان 20% وغاز البيوتان 80% . نظام التدفئة الثانى وهو إستخدام الغاز الحيوى (البيوجاز) والشعلة المفتوحة المباشرة للتدفئة بداخل عنبرالتربية وفي حالة نضوب البيوجاز يستخدم الوقود الاحفوري من أسطوانة الغاز المسال حيث يتم التحويل يدوياً باستخدام صمام خاص. نظام التدفئة الثالث وهو إستخدام اسطوانة الغاز المسال مع السخان الأتوماتكى المصنع والأنابيب المثقبة الداخلية بالعنبر لتوزيع الهواء. نظام التدفئة الرابع (النظام الجديد الأتوماتيكى) حيث يتم إستخدام الغاز الحيوى (البيوجاز) وأسطوانة الغاز المسال مع السخان الأتوماتكى المصنع والأنابيب المثقبة الداخلية بالعنبر لتوزيع الهواء. دلت النتائج المتحصل عليها علي الآتي: إستخدام الغاز الحيوى (البيوجاز) أدى إى زيادة كتلة الطائر في نهاية دورة التربية (6 أسابيع) بحوالي 3% وكذلك زيادة الوزن الكلي للطيور في وحدة التربية بحوالي 4% تقريبا. إضافة الي زيادة معامل كفاءة الإنتاج بحوالي 10.3% مقارنة بالمعاملة الاولي (معاملة المقارنة). تطبيق النظام التقني الجديد ساهم في زيادة وزن الطائر بعد الأسبوع الأول والثاني بحوالي 175 ،163% بالترتيب مقارنة بحالة البداية. إضافة الي زيادة كلا من وزن الطائر في نهاية دورة التربية بحوالي 30%، ومعدل التغذية بمعدل يتراوح بين (6 – 8%). وكذلك تطبيق النظام الرابع الجديد زاد من معدل بقاء الدواجن علي قيد الحياة بحوالي 6%. وبالتالي تقليل نسبة الوفيات للدواجن. أيضا تطبيق التكنولوجي الجديد (نظام التدفئة الرابع) مع استخدام الغاز الحيوى (البيوجاز) قلل من نسبة تحويل الغذاء بحوالي 85% مقارنة بمعاملة المقارنة. كذلك تطبيق نظام التدفئة الجديد قلل من استهلاك الطاقة المستهلكة بحوالي 53%، وحسن من متطلبات الطاقة النوعي حيث قل بحوالي 66% مقارنة بنظام التدفئة الأول.

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