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Effect of Different Brooding Sources on Growth, Blood Glucose, Cholesterol and Economic Appraisal of Three Commercial Broiler Strains

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MSS conducted this study. SM, AM and AJ supervised the research. MY and ASJ helped in reviewing the manuscript. SA helped in statistical analysis and formatting of manuscript. JH helped in data collection and execution of experiment.

Key words
Heating systems, Growth, Economics, Glucose, Cholesterol.

ABSTRACT

The concept of using different brooding systems was evaluated by using 720 day-old commercial broilers, 240 from each of the 3 strains (Ross 308, Cobb 500, Hubbard classic). All the chicks having uniform body weight were randomly distributed into 36 replicates having 20 birds each according to completely randomized design and were fed the same quantity of feed. The birds were subjected to 4 heating systems during brooding (Floor Heating, Diesel, Gas and Electricity Bulb). Growth performances, blood glucose, cholesterol level and economic appraisal in term of running cost / Kg of live meat were recorded. The results revealed that all strains generally but Ross 308 particularly maintained on floor heating system (FH) exhibited significantly ($P<0.05$) better FCR, EEF and livability along with higher glucose and lower cholesterol level in blood with better immune response that led to higher profit margin. All these parameters were significantly ($P<0.05$) lowest on gas brooder in comparison of brooding systems.

INTRODUCTION

Among the disciplines of management, brooding is the most critical segment of commercial poultry, where the foundation has been laid for a healthy flock. The term "brooding" means to provide an environment (especially temperature) in the poultry house where, the chicks feel comfortable in initial phase of life and brooding temperature can be decreased 2.8°C/week to a limit (North and Bell, 2004). Any failure in the provision of adequate environmental conditions during this phase may hamper the growth performance (Fairchild, 2012). The money that will be saved on the fuel bill will not compensate the money lost in bird performance (Deaton *et al*., 1996).

A good range of technologies are available for brooding. However, there are a number of advantages and disadvantages to each type of brooding equipment but poultry producers must consider many factors prior to investment, including capital costs, operating costs and performance like heat output and heat distribution (Czarick, 2008). Haq and Akhtar (2004) favored the wood brooders for open houses although such brooders produce smoke and uneven temperature inside the house. While, Ahmed *et al*. (2008) in their study found that gas brooders are more economical than others. Diesel brooders commonly used in environmental control houses are convenient to operate and efficient to run but very expensive along with environmental hazards and such brooders have to warm the air of shed up to 49°C to warm bedding (32°C) (Farmers, 2013). Pancake (electric bulbs brooder) cannot be used in commercial farming being expensive and difficult to manage.

Floor heating (FH) is thought to be a new and a better option for heating the poultry sheds as the heat is delivered at the bird level according to requirement. FH system can be up to 50% more efficient and economical than conventional heating system (ECOTEC Pvt.). Traditional air heaters warm the air up to 40°C to provide 32°Cat floor level, while, FH system not only provides warm bedding but keeps the litter dry that is important for good performance of birds. FH has reduced energy expense along with improvements in the performance and health status by many folds (Speller, 2011; Nahashon *et al*., 2005).Genetic potential of a broiler strain is a primary influential factor which needs appropriate di*et al*ong with suitable environmental conditions for optimum growth

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performance (Kao *et al.*, 2011). Although growth is a complex phenomenon that is controlled by genetic (breed) and non-genetic factors (nutrition and management) yet body weight is an important parameter for measuring growth in meat type chicken. Thus, these strains may give variable results of growth and carcass qualities under similar conditions of management and nutrition (Shim *et al.*, 2012). All traits are biologically correlated due to pleiotropic effect of genes and linkage of loci (Rosario *et al.*, 2008). McKay (1997) remarked that the performance of the modern broiler strains is due to selective breeding. Keeping in view the above discussion, the present study was conducted to investigate the effect of different brooding systems on growth performance, blood glucose and cholesterol, and economic efficiency in three broiler strains.

MATERIALS AND METHODS

The present study was conducted to evaluate the growth performance of 3 commercial broiler strains (Hubbard classic, Ross-308 and Cobb-500) maintained under 4 brooding systems (FH, gas brooder, conventional electric bulb brooder and diesel brooder) in environmental control house. A total of 720 day old broiler chicks (240 chicks from each strain) were divided according to completely randomized design into 36 replicates having 20 chicks each. The parent flocks of the experimental chicks were almost of the similar age (42-43 weeks).The experimental birds were maintained on litter (rice husk) and same quantity of feed was offered for 35 days of age. In first brooding system gas brooders have gas (LPG) cylinders linked with common room heaters were used. In second heating system iron water channels embedded in floor were used through which hot water were pass on to provide brooding temperature. In the 3rd heating system, electric bulbs hover brooders (Pancake) having 03 bulbs each of 100 watts were used. While 4th heating system was a small diesel brooder, consumed diesel 4 litter per hour and produced 9000 BTU.

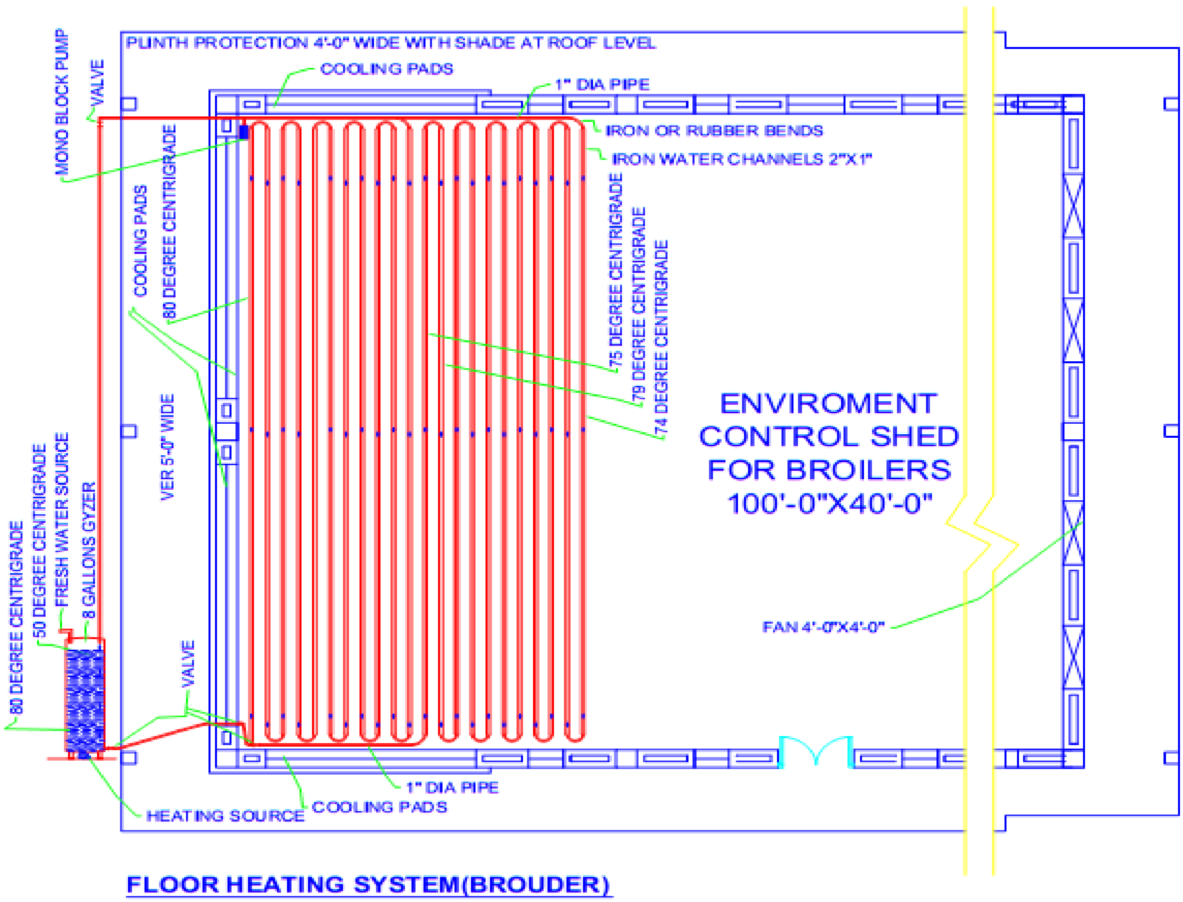

Fig. 1. Diagrammatic scheme of floor heating system (Brouder).

Table I.- Growth performance influenced by different heating sources and broiler strains.

Parameters		Body weight gain (g)	Livability (%)	FCR	EEF	Uniformity (%)
FHS		1910.30±19.21[a]	98.07±0.14[a]	1.541±0.04[b]	385.13±19.23[a]	81.39±2.90[ab]
Electricity		1848.26±69.78[ab]	95.55±0.17[ab]	1.60±0.03[ab]	317.25±15.85[ab]	79.00±3.00[b]
Gas		1800.97±43.26[b]	94.00±0.60[b]	1.636±0.04[a]	283.22±18.20[b]	67.22±5.35[c]
Diesel		1861.81±33.16[ab]	96.55±0.17[ab]	1.58±0.03[ab]	337.20±6.71[ab]	80.78±2.55[ab]
Strains						
Cobb		1837.83±38.97[ab]	95.33±0.33[ab]	95.58±0.14[b]	55.12±0.42[b]	80.88±3.78[ab]
Hubbard		1835.38±45.04[ab]	96.28±0.88[ab]	97.00±0.37[a]	56.29±0.49[ab]	79.00±9.25[b]
Ross		1880.04±22.95[a]	95.26±0.15[ab]	95.70±0.44[b]	57.16±0.46[a]	80.34±2.08[ab]
Strains × brooding sources						
Cobb	FHS	1888.26±25.27[ab]	96.66±0.33[b]	1.55±0.07[ab]	364.58±40.55[ab]	83.80±2.80[a]
	Electricity	1826.75±77.67[bc]	95.66±0.33[bc]	1.61± 0.08[ab]	336.79±34.19[abc]	80.95±3.99[ab]
	Gas	1818.82±23.02[bc]	93.06±0.30[c]	1.61±0.02[ab]	254.33±23.17[c]	73.00±7.43[bc]
	Diesel	1867.50±33.56[ab]	96.33±0.33[b]	1.57±0.03[ab]	334.72±2.81[abc]	82.50±5.74[ab]
Hubbard	FHS	1900.75±26.88[b]	99.00±0.00[a]	1.55±0.08[ab]	389.28±30.74[ab]	80.28±2.91[ab]
	Electricity	1827.11±30.31[bc]	97.33±0.33[ab]	1.61±0.02[ab]	347.86±21.60[ab]	79.81±6.69[b]
	Gas	1722.22±117.54[c]	94.33±0.88[b]	1.71±0.12[a]	267.96±36.62[bc]	67.09±8.00[c]
	Diesel	1851.46±86.45[ab]	99.06±0.33[a]	1.59±0.07[ab]	349.30±16.68[ab]	81.90±2.73[ab]
Ross	FHS	1942.89±22.11[a]	97.66±0.33[ab]	1.50±0.07[b]	401.53±38.65[a]	81.00±3.65[ab]
	Electricity	1881.93±72.99[ab]	94.66±0.33[bc]	1.56±0.06[ab]	317.09±26.10[abc]	80.00±5.89[ab]
	Gas	1821.88±53.53[bc]	94.00±0.15[bc]	1.61±0.04[ab]	325.37±24.30[ab]	71.00±6.00[bc]
	Diesel	1867.47±48.31[ab]	97.66±0.33[ab]	1.57±0.04[ab]	337.58±11.47[ab]	80.00±2.99[ab]

FHS, floor heating system; Different alphabets on means within column show significant differences ($P \leq 0.05$).

Floor heating system (FHS)

FH comprised a geyser to warm the water with fire of wood, this hot water was being circulated by a mono-block low pressure pump in a series of water channels interconnected with each other. These water channels were made of iron, 20 feet long, 2 inch wide, 1 inch high and 8 inch apart from each other embedded in litter (rice husk) and fixed on floor of the brooding area. Through water channels the heat of this hot water was dissipated in to the litter through conduction phenomenon. The speed and number of circulation of this hot water was manipulated with a controller according to need of temperature, due to repeated circulation of hot water (80°C), the temperature of litter was raised to 32°C or even higher. After passing through channels, the temperature of water reduced to 50°C or even less which was made hot by geyser (80°C) easily without consuming much energy. All the general protocols were adopted regarding management, record keeping, vaccination and medication. Body weight was recorded on weekly basis, while blood glucose and cholesterol, NDV antibody titer and economic efficiency was estimated at the end of trial.

Statistical analysis

The data were analyzed through two-way ANOVA (Steel *et al*., 1997) using PROC GLM in SAS software, the comparison of means were made through Tukey's HSD test.

RESULTS

Body weight gain

In his study, brooding systems and strains showed variation regarding body weight gain. Significantly ($P<0.05$) the highest body weight was gained by the birds reared under FHS and the lowest by those of gas brooders. With respect to the strains (Table I), significantly ($P<0.05$) the highest weight was attained by Ross followed by Cobb which is marginally ahead of Hubbard. In interaction, significantly ($P<0.05$) the highest weight gain was attained by Ross strain over FHS and the lowest in Hubbard under gas brooder.

Livability %

Significantly ($P<0.05$) the best livability% was recorded when all the birds of the three strains were kept on FH particularly of Hubbard, while, the least livability was found on gas brooders in general for all strains and for Cobb in particular (Table I).

Table II.- Blood profile influenced by different heating sources and broiler strains.

Parameters	HI Titer	Glucose (mg/dl)	Cholesterol (mg/dl)
FHS	5.95±0.40[a]	169.78±5.07[b]	111.11±1.90[a]
Electricity	5.53±0.63[ab]	215.00±4.49[a]	79.11±3.01[b]
Gas	4.50±0.62[b]	231.34±2.97[a]	79.00±1.60[b]
Diesel	4.83±0.64[ab]	189.67±7.78[ab]	99.89±3.12[ab]
Strains			
Cobb	5.41±0.35	200.33±4.64	91.08±4.48
Hubbard	5.47±0.29	205.67±7.48	89.58±4.88
Ross	5.53±0.26	196.58±8.34	93.17±4.43
Strains × brooding sources			
Cobb			
FHS	5.87±0.50[b]	170.00±2.8[bc]	101.67±4.41[abc]
Electricity	5.44±0.50[abc]	215.67±7.45[ab]	77.33±1.45[bc]
Gas	4.50±0.50[bc]	241.67±6.00[a]	77.00±1.15[bc]
Diesel	5.75±0.50[abc]	184.00±2.08[bc]	108.33±4.41[ab]
Hubbard			
FHS	5.99±0.50[a]	168.33±8.82[c]	113.00±4.04[a]
Electricity	5.50±0.50[b]	209.33±12.02[abc]	75.00±2.08[c]
Gas	4.43±0.50[c]	227.00±2.51[b]	92.00±6.03[bc]
Diesel	5.81±0.50[a]	179.00±7.64[bc]	78.33±4.41[bc]
Ross			
FHS	6.00±0.50[a]	167.33±10.93[c]	116.00±3.06[a]
Electricity	5.64±0.50[ab]	214.67±6.01[ab]	85.00±8.67[bc]
Gas	4.57±0.50[bc]	237.00±7.00[ab]	81.67±2.03[bc]
Diesel	5.88±0.50[ab]	182.33±12.02[bc]	102.00±1.15[ab]

Different alphabets on means within column show significant differences (P≤0.05).

Feed conversion ratio (FCR) and European efficiency factor (EEF)

The results of the study (Table I) revealed that all the strains maintained under FH exhibited significantly (P<0.05) the best FCR and EEF, while, significantly (P<0.05) the worst FCR and EEF were observed under gas brooders.Ross excelled (P<0.05) in FCR and EEF when it was reared on FH and Hubbard showed significantly (P<0.05) the worst FCR and EEF on gas brooders.

Uniformity %

Regarding uniformity, significantly (P<0.05) the worst body weight uniformity was observed on gas brooders and electric brooder, respectively (Table I), While, birds exhibited better uniformity on FH, marginally followed by diesel brooders. Among the strains, Cobb seemed significantly the most uniform on FHS and Hubbard looked significantly (P<0.05) the least uniform especially when it was reared on gas brooders.

Antibody response against New Castle disease

All rearing systems separately and in interaction showed variations in antibody titer against NDV. NDV antibody titer was found significantly (P≤0.05) higher in FHS, while, the lowest was recorded in birds reared at gas brooding system. On the other hand strains did not show any significant (P≤0.05) response to ND vaccine regarding antibody titer. In interaction, generally all three strains responded positively on FH but Ross particularly manifested the (P≤0.05) best titers (6.00±0.50) as compare to others.

Glucose and cholesterol level in blood

In this study, birds reared on different brooding systems showed differences in blood glucose level (Table II). Significantly (P<0.05) the highest glucose level was recorded at gas brooding, while, the lowest at FH. Different strains did not show any variation in blood glucose. Regarding blood cholesterol, the lowest level was recorded at gas brooding system, while, the highest at FH. Different strains did not show any major difference in their glucose level.

Economic appraisal of brooding systems

The results revealed that FH is the most efficient and beneficial brooding source for all the broiler strains resulting in the best weight gain, FCR, livability (Fig. 2). It was comparatively economical (Rs. 5/bird), followed by gas brooders (Rs. 7.3/bird).

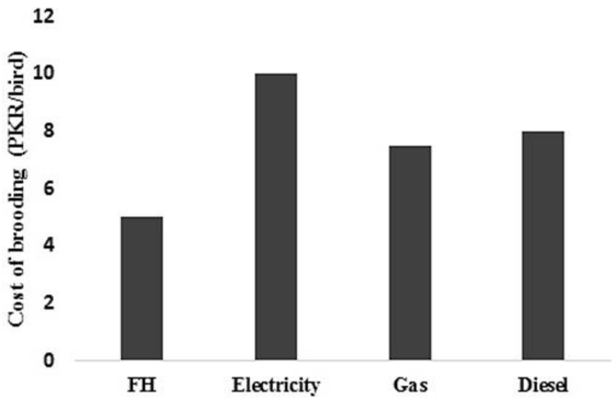

Fig. 2. Economical appraisal of 4 brooding sources.

DISCUSSION

Body weight gain

Better growth performance at FHS might be due to the provision of best brooding conditions like homogeneous distribution of temperature at the bird's level, warm and dry litter (Leva *et al*., 2013) that might have mitigated the enteric diseases and production of noxious gases (NH_3, CO_2, CO) which are the basic pre-requisites for good production performance (Miles *et al*., 2004). Actually, DOC is mainly dependent on the floor contact to regulate its body temperature and warm bedding is essential to facilitate bird's normal behavior (Cooper, 2009). FH has been considered to be the best system to accomplish the brooding requirements. Similarly, Speller (2011) found that FH improved the growth performance along with health status of birds by many folds. Although (Ahmed *et al*., 2008) reported that gas brooders are more economical than any other brooders yet these gas brooders could not provide suitable environmental conditions during brooding which would led to poor growth performance (Fairchild, 2012).

Higher weight was gain by Ross might be attributed to different genetic potential having different body requirements (Amao *et al*., 2011). Difference in growth performance in different strains under similar environmental conditions have already been observed in another study (Shim *et al*., 2012). The highest weight gain by Ross strain over FHS may be attributed to the fact that the FH was more comfortable for all strains in general and Ross in particular to accomplish their brooding requirements than those of other brooding systems. Although, basic requirements of all strains are the same, yet the FH would have appropriately fulfilled the physiological needs of all the strains used in this experiment. Similarly (Leva *et al*., 2013) found that FH could provide the most suitable brooding environment.

Livability %

Better livability on FH particularly of Hubbard might be due to the fact that FH might have provided more favorable conditions in terms of temperature, hygienic litter and minimum noxious gases for all birds and fluctuation of brooding temperature under rest of brooding sources would have resulted into high mortality (Ahmed *et al*., 2008). Hubbard showed relatively better resistance to diseases, these results are also in accordance with the findings of (Iqbal *et al*., 2012) as genetic differences exist between various broiler strains for immune responses (Gerald *et al*., 2003).

Feed conversion ratio (FCR) and European efficiency factor (EEF)

The best FCR and EEF exhibited by birds reared under FH system could be due to the fact that FHS would have provided the best brooding conditions in the shed required for optimum growth for all strains in general and for Ross in particular. While, the competitor brooding sources (diesel, gas, electric brooders) could not provide comfortable brooding temperature which would have hampered the growth (Fairchild, 2012; Malheiros *et al*., 2000). Although, gas brooder appeared a bit economical after FHS yet these were least beneficial for growth and health of the all strains. These results are contrary to the findings of Ahmed *et al*. (2008), who observed that the gas brooders were more economical and efficient than electricity and wood brooding. Best FCR and EEF of ROSS on floor heating system indicates that experimentally provided conditions were the most suitable for Ross. Even under similar conditions, broiler strains have the tendency to behave independently (Shim *et al*., 2012).

Uniformity %

Cobb strain revealed better uniformity reared under FH system and it can be argued that uniformity depends primarily upon brooding conditions (mainly on temperature), if DOCs were selected having uniform (±5%) body weight at hatchery to rule out this factor being an etiology of variable uniformity of a broiler flock. Thus, solely it would be the brooding conditions (temperature) which have affected the uniformity of the birds. Results are evident that FHS and diesel brooders provided uniform and steady temperature according to the bird's requirement. Gas brooders failed to manage the required conditions which might lead to poor uniformity especially exhibited by Hubbard. Up to 80% flock uniformity is being considered an uniform flock, while less than70% uniformity is poor one (Anonymous, 2012). The level of uniformity basically dictates the final result; poor flock uniformity goes hand in hand with delayed growth, rejects, and poor FCR (Anonymous, 2005).

Antibody response against New Castle disease

Same vaccine schedule for NDV adopted, yet the provoked immune responses were observed quite variable under different brooding systems. It can be assumed that immune response depends upon several factors including health status and micro-climatic conditions (Yonash *et al*., 2001; Knowles *et al*., 2008). As, the overall results of this study showed that birds felt more comfort on FH which might have provided such conditions (Colibasilosis and coccidiosis free along with establishing suitable temperature) at which birds immune system responded positively to the ND live vaccines (Vijendravarma *et al*., 2009). According to Heller *et al*. (1992) better general disease resistance might be gain by selection of chicken lines for antibody response against a non-replicating antigen resulted in better response to other antigens contrary to Lin *et al*. (2000), who illustrated that there is hardly any difference in immune response in various strains of poultry.

Glucose and cholesterol level in blood

The highest glucose level was observed in birds reared under gas brooding, while, cholesterol level was found to be higher in birds reared under FH system. It is evident from the results that concentration of glucose is reciprocal to the cholesterol. It seemed that the need for glucose increases during heat stress (Soleimani, 2010) as observed in birds reared at gas brooding system. The increase in plasma glucose might be an indicative stimulation of gluconeogenesis processes as a direct response to increased epinephrine, norepinephrine, and glucocorticoid secretion (Borges *et al*., 2003). Since exposure of thermal shock, reduces the feed consumption, the hepatic storage of glycogen might be the first available sources of energy leading to elevation of glucose in blood (Faisal *et al*., 2008; Blahová *et al*., 2007). So, glucose was higher in those birds who experienced some stressful environment (gas brooder) (Olanrewaju *et al*., 2010) contrary to cholesterol level. Some researchers like Rajman *et al*. (2006) are convinced that blood biochemistry can be influenced by genetic makeup, housing conditions, seasonal variation, sex and strains of chicken contrary and thermal shock led to hypoglycemia (Sahin *et al*., 2002; Nazifi *et al*., 2003)

Economic appraisal of brooding systems

FH was comparatively economical, although gas brooders are economical (Ahmed *et al*., 2008) to electric and diesel brooders respectively, but led to least livability having adverse effects on bird's health. FHS has reduced energy expense along with improvements in the performance and health status by many folds (Speller, 2011) as it provided warm bedding (ECOTEC) which might facilitate the maximum stocking density (Rehau Pvt. UK). While, traditional air heaters (diesel, gas and electric brooders) warmed the air contrary to the litter. Thus, FH mitigated the ammonia production which is highly detrimental for the birds (Miles *et al*., 2004) and need of ventilation.

CONCLUSION

Based upon the results of this study, it can be concluded that floor heating (FH) system is proved comparatively more efficient and economical than other heating systems which results into better growth performance, improved feed efficiency and better turn over along with increased glucose with lowered Cholesterol in all broiler strains but Ross 308 in particular.

Statement of conflict of interest

The authors declare that they have no conflict of interest.

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