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THE EFFECT OF THE ADDITION OF CELLULOSE ON THE QUALITY AND THERMAL PROPERTIES OF STRAW BEDDING

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The objective of the study was to determine the effect of the addition of recycled cellulose on the quality and temperature of the straw bedding. Starting from week 2 of the production cycle temperatures were registered and the degree of encrustation of both the cellulose and straw bedding was determined. The cellulose bedding was characterized by higher temperatures throughout the production cycle except for weeks 10., 12., 13. and 14. The warmer bedding meant that the appearing encrustation did not restrict the diffusion of vapour and gases. It exhibited more beneficial, aerobic conditions for exothermic processes. The narrower span of temperatures indicates a more uniform temperature of the cellulose bedding. The flock reared on the warmer and better-quality cellulose bedding reached higher final body weight.

Keywords: recycled cellulose, straw, bedding, encrustation, temperature

1. INTRODUCTION

The deep litter systems of managing animals are among the most commonly used in poultry production [2, 11]. The litter is primarily used to ensure the animals proper isolation from the floor as well as moisture absorbency and evaporation [1]. Excessive moisture in the bedding can lead to its lumping and even the forming of thick compact crust on its surface [2, 4, 8]. Cold and low-quality bedding contributes to muscles and feet conditions in poultry (FPD), plumage defects or breast blisters, which lower the carcass class [7, 13].

Therefore, good bedding material should, as long as it is possible, preserve its physical structure conducive to the diffusion of the bedding - air gases as well as provide the animals with warm and comfortable lying area.

The quality and temperature of the bedding is important not only during growing but also during the fattening stage as animals are in direct contact with

it and also because currently bred broilers are less tolerant of unfavourable environmental conditions [8, 9, 12].

Of numerous bedding materials (incl. sand, wood shavings, corncobs, tree bark) [5] straw is the most frequently used one [3, 7]. Since straw is characterized by very average sorptive properties, in order to improve those, a variety of supplements are added to the straw bedding [6, 10]. As confirmed by research, straw beddings with the addition of brown coal and a bacterial vaccine were characterized by higher temperatures, which was beneficial for their quality [11].

The objective of the study was to determine the effect of the addition of recycled cellulose[1] on the quality and temperature of the straw bedding during the growing and fattening of turkey pullets in the long fattening system.

2. MATERIALS AND METHODS

The study was conducted at a livestock facility – a turkey house, consisting of two sectors, 550m² of area each. The first sector was laid with a 10-cm layer of rye straw, the humidity of this layer was 8% (CSB - control straw bedding). The other sector was laid with a 5-cm layer of rye straw strewn with a 5-cm layer of recycled cellulose, and the humidity of this layer was 6,5% (RCB - recycled cellulose bedding). In either type of bedding, in representative places (not in the vicinity of feeders and drinkers or along the sidewalls and endwalls) a set of two probes were installed at the depth of 5 cm to measure the temperature.

The probes were connected to the HOBO recorder. The recorded temperature values of the studied bedding types throughout the production cycle were analysed with the BoxCar Pro 4.6 program.

On so-prepared beddings 6000 one-day-old BIG-6 turkey hens were placed in each sector respectively.

The production cycle lasted 15 weeks and at week 7 the stock's density was reduced.

The feeding, watering, heating and ventilation systems as well as the lighting and feeding programmes in both sectors were the same.

Starting from week 2. of the production cycle, every week, in 6 representative places in either sector, the degree of encrustation was determined according to a 10-point scale, on which each following degree includes the previous ones:

0 - no encrustation,
1 - an approx. 20-cm ring of encrustation around feeders and drinkers,
2 - a 50-cm strip of encrustation along the endwalls,

[1] In this experiment the cellulose was used in the form of a wad, which is safe for the health and welfare of turkeys.

3 - invisible yet foot-detectable crust on 50% of the bedding surface,
4 - invisible yet foot-detectable crust on 80% of the bedding surface,
5 - invisible and thin yet foot-detectable crust on 100% of the bedding surface,
6 - as above but crust readily detectable for feet, ≤ 5cm thick,
7 - visible patches of crust on 50% of the bedding surface (approx. 5cm thick),
8 - visible patches of crust on 100% of the bedding surface (approx. 5cm thick),
9 - 100% of the bedding surface covered with hard compact crust (approx. ≤ 7cm thick),
10 - as above but the crust approx. 10cm thick.

After the production cycle had been finished, samples of the bedding were taken in order to determine its moisture levels. Control measurements of the temperature and air humidity inside the building, in the animal area, were also taken. With the production cycle finished, the birds' body weight was measured by weighing approx. 1900 heads from either sector.

For statistical analysis the STATISTICA 9.1a. program suite was used.

3. RESULTS AND DISCUSSION

Table 1. compares the mean temperature values for the cellulose bedding (RCB) and the straw bedding (CSB) in the analysed weeks of the production cycle.

Week of production cycle	Bedding type	
	RCB	CSB
	Temperature [^{o}C]	
II	29,5	28,6
III	28,6	27,9
IV	25,8	22,6
V	24,3	22,1
VI	23,3	20,5
VII	22,1	20,5
VIII	21,3	20,5
IX	20,5	19,7
X	19,7	20,0
XI	19,9	19,9
XII	20,1	20,1
XIII	20,2	20,6
XIV	20,3	20,7
XV	20,4	20,3

Source: author's calculations

As confirmed by the data in table 1. the cellulose bedding, as compared with the straw bedding, was characterized by higher temperature values throughout the production cycle except for weeks 10., 12., 13. and 14.

At weeks 2. and 3. of the turkeys' growing the temperature of RCB was higher than that of CSB by 0,85 and 0,71^{o}C respectively. The statistical analysis showed that these were not statistically significant differences.

The temperature of RCB at weeks 4. and 5. was higher than that of CSB by 3,2 and 2,15^{o}C respectively. These were statistically highly significant differences ($p<0,001$).

In the subsequent weeks 6. and 7. of the production cycle the temperature of RCB was higher than that of CSB by 2,78 and 1,62^{o}C respectively. These were statistically highly significant differences ($p<0,001$).

At weeks 8. and 9. of the fattening stage the temperature of RCB was also higher than that of CSB by 0,98 and 0,72^{o}C respectively. The statistical analysis showed that these were not statistically significant differences.

At week 10. of the production cycle the temperature of RCB was lower by 0,33^{o}C than that of CSB. This was not a statistically significant difference.

At week 11. of fattening the temperatures of the studied bedding types were similar (difference: 0,03^{o}C). At weeks 12., 13. and 14. of the production cycle RCB was characterized by lower temperature values than CSB, however the differences of 0,06, 0,42 and 0,4^{o}C respectively were not statistically significant. In the last week 15. of the fattening stage the temperature of RCB was higher than that of CSB by 0,3^{o}C. This was not a statistically significant difference.

In the course of the production cycle the temperatures of both bedding types were decreasing - the drop was 9,05^{o}C for RCB and 8,33^{o}C for CSB. The decreasing temperatures of the beddings are partly due to the fall in air temperature in the turkey house (from 34,9^{o}C to 18,2^{o}C in the RCB sector and from 34,8^{o}C to 15,7^{o}C in the CSB sector). A decrease in temperature of the bedding during the production cycle is beneficial as growing animals are becoming less particular about thermal conditions; they can also give up the excess of heat to the colder litter.

Higher temperatures of both bedding types starting with week 12. of fattening despite lower temperature values of the environment indicate that there were exothermic processes taking place in both beddings.

Table 2. compares the minimal and maximum temperature values of the studied bedding types and the temperature spans in the analysed weeks of the production cycle.

Week of production cycle	RCB			CSB		
	Temperature [^{o}C]					
	Min	Max	R	Min	Max	R
II	27,89	30,39	2,5	27,18	30,25	3,07
III	27,21	29,76	2,55	26,49	30,55	4,06
IV	24,34	27,14	2,80	21,46	23,73	2,27
V	22,65	25,82	3,17	21,33	23,15	1,82
VI	22,51	24,45	1,94	16,49	21,84	5,35
VII	21,26	22,67	1,41	18,28	21,70	3,42
VIII	20,40	22,71	2,32	18,28	21,52	3,24
IX	19,45	21,89	2,44	19,04	20,78	1,74
X	19,11	20,71	1,60	19,12	20,68	1,56
XI	18,10	20,75	2,65	18,54	20,87	2,33
XII	19,55	20,30	0,75	19,58	20,46	0,88
XIII	19,58	21,15	1,57	19,89	21,27	1,38
XIV	19,79	21,14	1,35	20,14	21,75	1,61
XV	19,24	21,21	1,97	19,98	21,20	1,22

Source: author's calculations

At weeks 2., 3., 6., 7., 8. and 14. of the production cycle RCB was characterized by a narrower spans of temperatures than CSB. At weeks 10., 12. and 13. temperature spans were similar for both RCB and CSB.

At weeks 4., 5., 9., 11. and 15. of the production cycle the cellulose bedding was characterized by a wider span of temperatures as compared to CSB.

The narrower span of temperatures of the RCB (from 0,75 to 3,17°C) as compared to CSB (from 1,22 to 5,35°C) points to a more uniform temperature of the bedding with the addition of cellulose.

Beddings with even temperatures create more beneficial conditions for a uniform distribution of birds over the whole area of the house, especially in the initial weeks of the cycle.

Table 3. Degree of encrustation of cellulose bedding (RCB) and straw bedding (CSB) in the consecutive weeks of production cycle [10-point scale]

Bedding type	Week of production cycle													
	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
	Degree of encrustation on 10-point scale													
RCB	0	0	0	1	1	2	3	5	5	6	7	9	10	10
CSB	0	1	2	4	4	6	7	8	9	10	10	10	10	10

Source: author's calculations

Table 3. presents the degree of encrustation of the studied bedding types in the analysed weeks of the production cycle. In the cellulose bedding the first signs of encrustation were observed at week 5. of the cycle, whereas in the straw bedding already at week 3. of the growing stage. The process of encrustation advanced consecutively on both bedding types but much more slowly so on the cellulose bedding than on the straw bedding. It was not until week 14. of fattening that the cellulose bedding was covered with thick compact crust (degree 10), whereas on the straw bedding degree 10. of encrustation was found at week 11. of the cycle.

The more slowly advancing encrustation of the cellulose bedding did not restrict the diffusion of vapour and gases between the litter and the air in the building, thus the cellulose bedding exhibited more beneficial, aerobic conditions for exothermic processes. It was confirmed by the lower moisture level in RCB (58,2%) as compared with CSB (59,9%) as well as by the higher temperature levels of RCB than CSB (except for four weeks).

The final body weight of turkey hens reared on the warmer and better-quality cellulose bedding was 10,59 kg and was higher by 0,56 kg as compared to the hens reared on the straw bedding (10,03 kg).

4. SUMMARY AND CONCLUSIONS

The conducted study has shown that in the first seven weeks of the production cycle the cellulose bedding was characterized by higher temperatures than the straw bedding. The statistical analysis showed that the temperature differences between RCB and CSB were highly significant at weeks 4., 5., 6. and 7 ($p<0,001$).

Due to higher temperatures the cellulose bedding was subject to slower encrustation, with degree 1 of encrustation not found until week 5. of the cycle, whereas at the same time in the straw bedding it reached degree 4.

At weeks 8., 9., 11. and 15. of the cycle the temperatures of the cellulose bedding were higher than of the straw bedding, yet the statistical analysis showed that these were not statistically significant differences.

At weeks 10., 12., 13. and 14. of fattening the cellulose bedding was characterized by lower temperature values than the straw bedding. The statistical analysis showed that these were not statistically significant differences.

Despite slightly lower temperatures the cellulose bedding was still subject to slower encrustation than the straw bedding, which at week 11. was covered over its whole area with thick compact crust (degree 10). The last degree 10 of encrustation was not found in the cellulose bedding until week 14. of the fattening stage.

The more slowly advancing process of encrustation in the cellulose bedding than in the straw bedding did not restrict the diffusion of vapour and

gases between the litter and the air in the building, thus the cellulose bedding exhibited more beneficial, aerobic conditions for exothermic processes and water evaporation. With the production cycle finished, the cellulose bedding was less moist than the straw bedding.

The narrower span of temperatures of the cellulose bedding as compared to the straw bedding points to a more uniform temperature of the bedding with the addition of cellulose.

Beddings with even temperatures create more beneficial conditions for a uniform distribution of birds over the whole area of the house.

The flock reared on the warmer and better-quality cellulose bedding reached higher (by 0,56 kg) final body weight than the flock managed on the straw bedding.

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WPŁYW DODATKU CELULOZY NA JAKOŚĆ I WŁASNOŚCI TERMICZNE PODŁOŻA SŁOMIASTEGO

Streszczenie

Przeprowadzone badania miały na celu określenie wpływu dodatku celulozy pochodzącej z recyklingu, na jakość i własności termiczne podłoża słomiastego. W sektorze RCB indyczki utrzymywano na słomie z celulozą, w sektorze CSP tylko na słomie (sektor kontrolny). Od drugiego tygodnia cyklu produkcyjnego rejestrowano temperatury oraz określano stopień zaskorupienia podłoża celulozowego i słomiastego. Podłoże celulozowe miało wyższe temperatury w całym cyklu produkcyjnym, z wyjątkiem 10., 12., 13. i 14. tygodnia. Na cieplejszym podłożu celulozowym wolniej powstająca skorupa nie ograniczała dyfuzji pary wodnej i gazów. Panowały w nim korzystniejsze, aerobowe warunki dla przemian egzotermicznych. Węższe obszary zmienności temperatur wskazują na bardziej wyrównaną temperaturę podłoża z dodatkiem celulozy. Stado utrzymywane na cieplejszym oraz o lepszej jakości podłożu celulozowym osiągnęło wyższe masy końcowe.