

# WELFARE ASSESSMENT OF THREE CHICKEN BREEDS (*Gallus gallus domesticus*) UNDER DIFFERENT PRODUCTION SYSTEMS

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**Abstract:** The objective assessment of welfare in poultry under different rearing systems has gained an increasing importance. In particular, organic rearing systems are examined in relation to improving poultry welfare and the quality of poultry production at a worldwide scale. The aim of the present study was to assess the welfare of parent flocks – *White Plymouth Rock*, *Barred Plymouth Rock (Line F)* and *New Hampshire*, reared under two production systems – indoor on a litter and organic (sleep houses and walk yards). The rearing and microclimatic conditions, the poultry behaviour and blood plasma corticosterone concentrations under both farming systems were examined. The welfare assessment score of *White Plymouth Rock*, *New Hampshire* and *Barred Plymouth Rock*, reared indoor on a litter was 60%, whereas in an organic production system – 90%. The higher welfare of birds reared organically was determined by the greater number of birds spending their time in dust bathing ( $P<0.01$ ) and feather cleaning ( $P<0.05$ ) as well as by fewer episodes of aggression ( $P<0.01$ ) and plasma corticosterone levels ( $P<0.01$ ), as compared to chickens reared indoor on a litter.

**Key words:** welfare assessment, rearing, chicken behaviour, corticosterone

## Introduction

The objective assessment of welfare in poultry under different rearing systems has gained an increasing importance. The organic rearing systems are examined in relation to improving poultry welfare and the poultry production quality at a worldwide scale (*Anonymous, 2006 a,b*).

Stress has a negative impact on poultry welfare, and the stress itself could be provoked by a number of factors: technology drawbacks, poor microclimatic rearing conditions – increased ambient temperature and humidity, permanent exposure to ammonia concentrations close to maximum allowed, inappropriate

light regimen etc. (Smith and Teeter, 1981; Hocking et al., 2001; Sahin et al., 2002; De Jong et al., 2002a,b; Sahin and Kucuk, 2003).

Poultry behaviour is the most reliable indicator of welfare (Sherwin and Kelland, 1998; Broom, 2001; Platz et al., 2003; Martrenchar et al., 2001; Dawkins, 2003; Linares and Martin, 2010). Another sensitive parameter of stress-induced poor welfare in birds is blood plasma corticosterone (Sahin et al., 2002; Gonzales-Esquerria and Leeson, 2006; Lin et al., 2006; Mormède et al., 2007).

At a worldwide scale, there is an increasing interest in objective, mathematical evaluation of poultry welfare with regard to the unbiased comparison of physiological comfort of birds under different production systems (Huber-Eicher and Wechsler, 1997; Dawkins, 2003; De Mol et al., 2006; Linares and Martin, 2010).

The aim of the present research was to assess the welfare of three breeds of broiler breeders reared under two production systems – indoor on a litter in boxes and organic, in sleep houses and walk yards. For this purpose, we have evaluated microclimatic parameters, their behaviour and blood plasma corticosterone concentrations.

## Materials and Methods

The experiments were carried out with 312 broiler breeders (*Gallus Gallus domesticus*) from three breeds – White and Barred Plymouth Rock (Line F) and New Hampshire, 45 weeks of age, reared under two production systems – indoor on litter and organic (sleep houses and walk yards).

The investigations were carried simultaneously during the second half of May at two locations: the Poultry Production Base at the Institute of Animal Sciences – Kostinbrod and at the Poultry farm of the Department of Animal Science, Agriculture University – Plovdiv. The sex ratio in the flocks was 1 rooster per 8 hens.

In the first production system, broiler breeders were reared in groups of 52 birds from each strain on litter in group boxes with a density of 4 hens/m<sup>2</sup>, in one premise with natural ventilation. They were fed by round tubular feeders ensuring feeding and drinking widths of 4 and 3 cm respectively, as required by zoo hygienic norms (Anonymous, 2006a). For egg-laying, single-floor wooden nests with dimensions 30/30/40 cm were provided (4 hens in one nest).

In the organic production system, 52 hens from each breed were placed in heat-insulated sleep-houses (size 3.50/2.50/2.75 m) and walking yards (9.20/24 m). The houses included 3 perches, 2 m in length, and 8 two-floor wooden nests of 30/30/40 cm each. The light intensity was 1:10. In the bottom of the southern wall of houses, there was a 30/40 cm rectangular opening for access to the yard. In the middle of each yard, there were perennial broadleaf trees. Yards were provided with two rows of tubular feeders and with watering troughs ensuring

feeding and drinking widths of 10 and 3 cm, respectively as required by zoohygienic norms (*Anonymous, 2006a*). The chickens were fed ad libitum with a standard ration according to their category.

**Microclimatic conditions** were determined by routine methods. The temperature and the relative humidity of air were measured by a with a weekly thermohygrograph; the velocity of the air motion – with a catathermometer. the light intensity – with a luxmeter. the concentration of ammonia – with indicator tubes and Drager ammonia sensor and calculated in ppm.

**Blood samples** for analysis were obtained from six birds from each group on May 19 from v. subcutanea ulnaris in sterile vacutainers. The duration of each manipulation was not longer than 2 min. i.e. lower than the maximum time that did not influence plasma corticosterone concentrations in birds (*Lagadic et al., 1990*).

**The behaviour** of parent flocks was recorded with a video camera for 12 hours during 4 consecutive days – from May 15<sup>th</sup> to 18. Based on the recordings we prepared ethogrammes as per Wojcik & Filus. 1997. During the ethological study we counted the number of birds engaged in specific forms of behaviour: ingestive (ingestion of water or food). gregarious (moving. lying. egg-laying. dust bathing and feather cleaning) and agonistic and sexual behaviour as per *Popova-Ralcheva (1994)*.

**Plasma corticosterone levels** were assayed with immunoenzymatic ELISA kit (Corticosterone ELISA RE52211, IBL Gesellschaft fur Immunchemie und Immunbiologie MBH, Hamburg, Germany) in the Laboratory of Innate Resistance Investigation at the Veterinary Genetics and Breeding Unit, Department of General Animal Breeding, Faculty of Veterinary Medicine – Stara Zagora.

**The welfare assessment score** was calculated by the system of *Bozakova (2004)*. It is based on the scientific concept of animal welfare of the UK Farm Animal Welfare Council (*FAWC, 1995*). It included the so-called five freedoms guaranteeing poultry welfare which are given a specific score: 2, 1 and 0, depending on expression of a particular behaviour and plasma corticosterone concentrations under different production systems.

The utmost importance in welfare assessment was attributed to the lack of pain, injury and disease. When some of these were present, regardless of other signs, the score was zero. The final score was obtained as a sum of numerical expressions of all freedoms and compared to the maximum possible score of 10, expressed in percentage.

**The statistical processing** of the results was performed by means of one-way ANOVA using the GraphPad InStat 3.06 software at level of significance  $P < 0.05$ .

## Results

The data for the microclimatic parameters of both production systems are given in Table 1.

Comparing the average temperature, air humidity and air movement velocity in the birds' living area with the veterinary requirements for animal breeding facilities, *Anonymous (2006a)* we determined that they were within the norms with some exceptions.

In the indoor production system, air humidity and ammonia concentration were at the upper allowed limits. For the organic system, the higher light intensity was due to the open-air rearing to which birds have adapted.

There were significant differences in the gregarious (lying, feather cleaning, dust bathing) and agonistic behaviour (aggression) behaviour of the flocks reared under different production systems (table 2). The number of lying *New Hampshire* and *Barred Plymouth Rock* hens was higher ( $P<0.05$ ) as did dust bathing birds from all breeds reared organically compared to those reared indoor ( $P<0.01$ ). The birds exhibiting aggression were also fewer ( $P<0.01$ ).

**Table 1. Microclimate parameters for the broiler breeder flocks at the different rearing systems**

Rearing system	Temperature, (°C)	Humidity, %	Ventilation, m/s	NH <sub>3</sub> , ppm	Lux, Lx
Indoor on litter - 4 hens/m <sup>2</sup>	18.5±0.2	70.13±0.50	0.27±0.005	12.54±0.36	31.25±1.74
Organic system-sleep houses and walk yards	20.5±2.5	61.88±0.54	0.50±0.04	follow	74.50±15.50
Reference values*	18 – 25	50 – 70	0.2 – 0.5	< 15	30 – 60

\*Reference values as per *Anonymous (2006 a)*

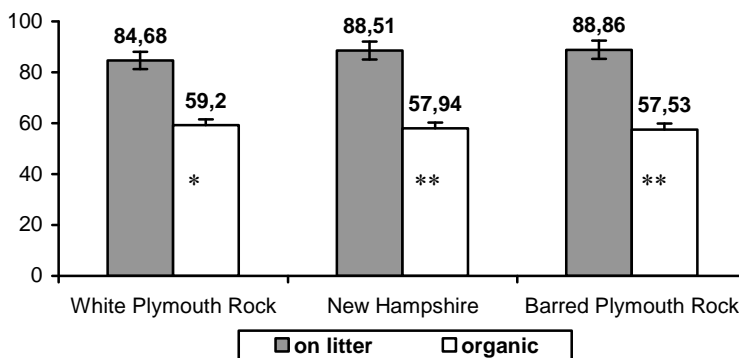
**Table 2. Number of White Plymouth Rock, New Hampshire, and Barred Plymouth Rock birds exhibiting a specific type of behaviour under two production systems (mean ±SEM, n=52).**

Behaviour	White Plymouth Rock		New Hampshire		Barred Plymouth Rock	
	Indoor on litter	Organic system	Indoor on litter	Organic system	Indoor on litter	Organic system
Feeding	12.82±1.44	13.50±1.22	12.90±1.42	13.82±1.26	13.00±1.38	13.64±1.28
Drinking	8.54±0.44	8.36±0.62	8.50±0.46	8.36±0.62	8.60±0.48	8.36±0.62
Egg-laying	3.22±0.50	2.86±0.46	3.18±0.50	2.86±0.46	3.22±0.50	2.86±0.46
Moving	13.90±0.62	14.86±0.90	13.72±0.62	14.72±0.92	14.00±0.62	14.60±0.84
Lying	3.36±0.52	2.28±0.42	3.54±0.54 <sup>#</sup>	2.28±0.42 <sup>#</sup>	3.54±0.54 <sup>"</sup>	2.28±0.42 <sup>"</sup>
Feather cleaning	0.82±0.14	1.08±0.26	0.78±0.14 <sup>#</sup>	1.28±0.26 <sup>#</sup>	0.86±0.16	1.10±0.26
Dust bathing	0.64±0.16 <sup>**</sup>	1.82±0.26 <sup>**</sup>	0.86±0.18 <sup>##</sup>	2.00±0.24 <sup>##</sup>	1.00±0.20 <sup>""</sup>	2.10±0.24 <sup>""</sup>
Aggression	4.40±0.24 <sup>**</sup>	0.64±0.18 <sup>**</sup>	4.18±0.24 <sup>##</sup>	0.64±0.18 <sup>##</sup>	3.96±0.24 <sup>""</sup>	0.50±0.12 <sup>""</sup>
Sexual behaviour	4.50±0.40	4.50±0.40	4.50±0.40	4.50±0.40	4.50±0.40	4.50±0.40

<sup>\*\*</sup> $P<0.01$  between White Plymouth Rock groups; <sup>#</sup> $P<0.05$ ; <sup>##</sup> $P<0.01$  between New Hampshire groups;

<sup>"</sup> $P<0.05$ ; <sup>""</sup> $P<0.01$  between Barred Plymouth Rock groups.

Changes in plasma corticosterone concentrations in breeder flocks (Fig. 1) showed statistically significantly higher levels for the three breeds when reared indoor on a litter ( $P < 0.01$ ).



**Figure 1.** Plasma corticosterone (nmol/L) levels in *White Plymouth Rock*, *New Hampshire* and *Barred Plymouth Rock* breeders reared under two different production systems (mean  $\pm$  SEM,  $n=6$ ). \* $P < 0.05$ ; \*\* $P < 0.01$  between two production systems within each breed.

Table 3 presents the total scores of welfare assessment for the two production systems studied. In organically reared birds, the freedom from discomfort, freedom from fear and stress were given a bigger score (2) due to the more intensive dust bathing ( $P < 0.01$ ), lower aggression ( $P < 0.01$ ) and plasma corticosterone ( $P < 0.05$ ,  $P < 0.01$ ) as compared to birds reared indoor.

**Table 3.** Welfare assessment scoring system under two different production systems

Welfare parameters	<i>White Plymouth Rock</i>		<i>New Hampshire</i>		<i>Barred Plymouth Rock</i>	
	Indoor on litter	Organic system	Indoor on litter	Organic system	Indoor on litter	Organic system
1. Freedom from thirst and hunger	2	2	2	2	2	2
2. Freedom from discomfort	1	2	1	2	1	2
3. Freedom from pain, injury and disease	1	1	1	1	1	1
4. Freedom to express normal behaviour	1	2	1	2	1	2
5. Freedom from fear and distress	1	2	1	2	1	2
Total score	6	9	6	9	6	9
Welfare assessment score, %	0.6	0.9	0.6	0.9	0.6	0.9
	60	90	60	90	60	90

## Discussion

The rearing of many birds indoor on litter, air humidity and air ammonia concentration were close to upper allowed limits and thus, act as stressors for birds, stimulating the secretion of corticosterone. This reflects upon the

behaviour of all three studied breeds - *White Plymouth Rock*, *New Hampshire*, *Barred Plymouth Rock*. When reared indoor, the number of birds performing feather cleaning and dust bath was significantly lower ( $P < 0.01$ ) and their aggressiveness increased ( $P < 0.01$ ), as compared to same breeds reared organically.

This confirmed the higher welfare of the experimental birds. Similar were the results of *Iliev et al. (1999)* which claimed that dust bathing was the uppermost demonstration of comfort in birds. According to *Sherwin and Kelland (1998)* and *Stoyanchev et al. (2006)* dust bathing is a reliable indicator of poultry welfare. That is why the freedom from discomfort and the freedom to express the normal behaviour organically reared breeders were assessed with a higher score (2).

Breeders reared indoor exhibited higher level of aggressions ( $P < 0.01$ ) compared to those reared organically. This is parameter of worsened welfare. Similar results were reported by *Popova-Ralcheva et al. (2002 a, b)* by affirming that agonistic behaviour and plasma corticosterone could be used as consistent indices of distress in poultry. That is why the birds reared indoor have received a lower score (1).

The increased aggression in the three breeds correlated to considerably higher plasma corticosterone concentrations ( $P < 0.05$ ,  $P < 0.01$ ), compared to birds reared under the organic production system. Elevated hormonal levels in response to microclimatic stressors in various bird species were reported by *Sahin et al. (2002)*, *Sahin & Kucuk (2003)*, *Sahin et al. (2004)*, *Gonzales-Esquerra & Leeson (2006)*, *Lin et al. (2006)*. According to *Popova-Ralcheva et al. (2002 a,b)* and *Mormède et al. (2007)*, blood corticosterone is a reliable indicator of the level of stress in poultry. This is also confirmed by the research of *Hocking et al. (2001)* and *Broom et al. (2001)*. Therefore, we have assess the freedom from fear and distress in birds reared indoor with 1.

The final total welfare scores of the three studied breeds of broiler breeders reared under different production systems was compared to the maximum possible score of 10 (100%). The welfare of *White Plymouth Rock*, *New Hampshire* and *Barred Plymouth Rock* hens reared indoor on litter was 60%, whereas for the organic production system – 90%.

## Conclusion

Broiler breeders reared indoor on litter were exposed to air humidity and ammonia concentrations close to the upper allowed limits, which acted as stressors, stimulated the release of corticosterone and ultimately resulted in altered behaviour.

The better welfare score of *White Plymouth Rock*, *New Hampshire* and *Barred Plymouth Rock* hens reared organically (90%) is determined by the greater number of birds spending their time in dust bathing and feather cleaning as well as by fewer episodes of aggression and plasma corticosterone levels as compared to welfare of the chickens reared indoor on litter (60%).

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## Ocena dobrobiti tri rase pilića (*Gallus gallus domesticus*) u različitim proizvodnim sistemima

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## Rezime

Cilj procene dobrobiti živine u različitim sistemima gajenja ima veliki značaj. Konkretno organski sistemi proizvodnje ispituju se u vezi sa poboljšanjem dobrobiti živine i kvaliteta živinskih proizvoda širom sveta.

Cilj rada je bio procena dobrobiti roditeljskih jata – *White Plymouth Rock*, *Barred Plymouth Rock (Line F)* i *New Hampshire*, gajenih u dva sistema – podni i organski (objekat sa ispustom).

Ispitivani su mikroklimatski uslovi, ponašanje živine i koncentracija kortikosterona u krvnoj plazmi u oba sistema gajenja.

Rezultati procene dobrobiti *White Plymouth Rock*, *New Hampshire* i *Barred Plymouth Rock*, gajenih u podnom sistemu su bili 60%, dok su u organskom sistemu – 90%. Bolja ocena dobrobiti pilića koji su organski gajeni određena je na osnovu većeg broja pilića koji su provodili vreme u kupanju u prašini ( $P < 0.01$ ) i čišćenju perja ( $P < 0.05$ ) kao i manjim brojem epizoda agresije ( $P < 0.01$ ) i nivoom kortikosterona ( $P < 0.01$ ) u poređenju sa pilićima gajenih u podnom sistemu.

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