ACTA SCIENTIARUM POLONORUM *Acta Sci. Pol., Zootechnica 10 (1) 2011, 3–12*

EGG QUALITY OF DUAL-PURPOSE HENS INTENDED FOR SMALL- SCALE FARMING

Michał Dudek, Andrzej Rabsztyn

University of Agriculture in Kraków, Poland

Abstract. The objective of the experiment was evaluation of some physical traits of egg quality in hens originating from Polish egg-type pedigree farms and destined for small-scale farming as well as in a breed of preserved chickens. 30 eggs from each of the three genetic groups (parental P55 Barred Rock strain, VH43 parental cross of V44 Rhode Island Red and H33 Leghorn strains, and the preserved Z11 Partridge Greenleg strain) were taken to analysis. The layers were maintained in the same environmental conditions and were under the same feeding regime. Analyses of egg quality were accomplished in 26th and 50th weeks of age, with an electronic EQM device. Egg weight in VH43 cross in the beginning of laying was 61.5 g and it was significantly bigger than in P55 hens (50.2 g) and Z11 hens (42 g). No statistical differences between experimental groups were found in shell thickness, shell density. Egg shell colour in P55 hens differed significantly from that in the other groups. The highest Haugh unit score (99.9) and albumen height (9.7 mm) were noted in the eggs of P55 hens in 26th weeks of age. These parameters lowered with age in all experimental groups. The highest proportion of yolk was found in the eggs of Z11 (29.5%) in 50 weeks of age. Yolk percentage increased with age in all genetic groups. Yolk colour index (La Roche) diminished with age of layers.

Keywords: egg quality, local Polish strains of hens

INTRODUCTION

Modern poultry production is characterized by the high level of intensification and globalization and the animals perfectly adapted to the intensive farming conditions and characterized by the low feed consumption and very good yield are in the lead. Resignation from the populations that are low-producing but adapted to local conditions is also the loss of many useful production traits such as resistance to diseases and unfavorable environmental conditions, very good quality of the meat and eggs being produced [Hoffmann 2005, Calik and Krawczyk 2006]. It poses a risk to the maintenance of genetic diversity since only few groups of the most productive commercial crossbreds are used for egg production. Therefore, the preservation of the native breeding material, which is also the preser-

Corresponding author – Adres do korespondencji: dr hab. Andrzej Rabsztyn, Department of Poultry and Fur Animal Science and Animal Hygiene, University of Agriculture in Kraków, Mickiewicza 24/28, 30-059 Kraków, Poland, e-mail: rzrabszt@cyf-kr.edu.pl

vation of the valuable pool of genes that can be lost, acquires particular significance [Cerolini et al. 2010]. In recent years, the consumers' increased interest in the quality of foodstuff, including eggs, can be observed in our country [Wężyk 2000, Krawczyk et al. 2005]. The egg quality is affected by both genetic and environmental factors. The effect of strain and prolonged selection for productive traits, laying rate, body weight, as well as interactions between strain and diet type, genetic and environmental correlations, genetic trends regarding egg quality traits have been presented i.a. by Wężyk [2000].

The outbreak of the "mad cow" disease and hoof-and-mouth disease was the beginning of the discussion on the safety of food offered for sale. Another issue is the opinions of part of the society on the worsening quality of food of animal origin available on the market and the opinions of ecological circles protesting against animal management conditions. Most protests are caused just by the poultry production and the battery keeping of layers [Frątczak et al. 2002]. It is considered that eggs and meat of better taste are obtained from hens farmed extensively, according to the welfare recommendations [Trziszka 2000, Andres et al. 2004]. Highly-specialized hens adapted to cage farming are not suitable for this purpose.

The aim of the study was the evaluation of the selected quality traits of eggs obtained from hens from the Polish pedigree farms intended for the rearing on small-scale farms and from the breed of hens included in the poultry genetic resources preservation program and kept on a commercial farm. The significant part of the study was the determination of the effect of genotype and age of layers on the physical properties of egg that are important from the consumer's point of view.

MATERIAL AND METHODS

The research material consisted of the eggs of Barred Plymouth Rock (P55) hens, VH43 crossbreds derived from the cross between Leghorn (H33) hen and Rhode Island Red (V44) cock and eggs from Partridge Greenleg hens (Z-11). Chicks for the experiment were reared under the same environmental conditions and fed the same balanced diet. The size of each group was approx 500 layers kept on litter, without access to the runs, fed *ad libitum* a standard balanced diet for layers without pigments. The eggs for the study were collected during two laying periods, i.e. at 26 and 50 weeks of age. Thirty eggs were randomly selected from each group. They were subjected to qualitative evaluation using the EQM (Egg Quality Measurements) apparatus. The following traits were determined: weight of egg, yolk and shell, thick albumen height, Haugh units (HU), color of shell and yolk and shell density. The shell strength (N) was measured with the Egg Crusher apparatus. The obtained results were subjected to statistical analysis. For the comparison of means, Tukey's test was applied using Statistica® 9.0 PL software.

RESULTS AND DISCUSSION

The results are presented in Tables 1–4. The mean weight of eggs from the VH43 crossbred hens at the beginning of laying, i.e. at 26 weeks of age, was 61.4 g and it was signifi-

cantly higher than the mean weight of eggs from the P55 and Z-11 hens, which amounted to 50.1 and 41.7 g, respectively. At 50th weeks of age, the mean egg weight was 68.9 g (VH43), 61.8 g (P55) and 56.0 g (Z-11).

The highest value of Haugh units (99.8 HU) was found in the eggs from the P55 hens obtained at 26th weeks of age compared to 95.2 HU obtained in the eggs from the VH43 crossbreds and 92.1 HU in the eggs from the Z-11 hens.

Table 1. Selected egg quality traits from VH43, P55 and Z-11 hens at the age of 26 weeks
Tabela 1. Wybrane cechy jakościowe jaj kur VH43, P55 i Z-11 w wieku 26 tygodni

Trait Cecha	26th week of life 26. tydzień życia					
	VH43		*P55*		*Z-11*	
	$\overline{x}$	V%	$\overline{x}$	V%	$\overline{x}$	V%
Egg weight, g Masa jaja, g	61.4C	4.4	50.1B	5.1	41.7A	5.4
Albumen hight, mm Wysokość białka, mm	9.3B	17.2	9.7B	11.7	7.6A	14.9
Haugh Units, HU Jednostki Haugha, HU	95.2	8.2	99.8B	4.8	92.1A	6.8
Yolk weight, g Masa żółtka, g	13.3B	7.7	11.3A	8.1	10.7A	9.7
Yolk proportion, % Udział żółtka, %	21.6A	7.7	22.5A	8.6	25.8B	9.7
Yolk colour (la Roche) Barwa żółtka (la Roche)	8.1B	9.9	5.8A	29.9	6.1A	25.6

A, B, C… values in lines with different letters differ significantly (P≤0.01).
A, B, C… wartości średnie cech oznaczone w wierszach różnymi literami różnią się statystycznie istotnie (P≤0,01).

Similarly, the greatest thick albumen height was characteristic of eggs from the P55 hens at 26th weeks of age (9.7 mm) compared to the VH43 and Z-11 eggs (9.3 and 7.6 mm, respectively) obtained during the same period. Both the value of Haugh units and the albumen height decreased with the course of laying in the eggs of all genetic groups, whereas the percentage of yolk in the egg increased in all the examined groups with increasing age of layers. The highest percentage of yolk in the egg was observed in the eggs from the Z-11 hens (29.4%) compared to 27.1% and 25.7% in the eggs from the P55 and VH43 hens, respectively. Although the percentage of yolk in the eggs from the VH43 crossbreds was the lowest in both the examined periods in comparison with eggs from the two remaining groups, the yolk weight in eggs from the VH43 hens was the highest compared to other genetic groups, both in the first and the second analyzed period (26th and 50th weeks of age, respectively). With the course of laying, the yolk color index (La Roche) decreased from 8.1 (VH43), 5.8 (P55), 6.1 (Z-11) in eggs at 26th weeks of age to 5.5, 4.4 and 5.2, respectively, at 50th weeks of age.

Table 2. Selected traits of egg shell from VH43, P55 and Z-11 hens at the age of 26 weeks
Tabela 2. Wybrane cechy skorupy jaj kur VH43, P55 i Z-11 w wieku 26 tygodni

Trait Cecha	26th week of life 26. tydzień życia					
	VH43		*P55*		*Z-11*	
	$\overline{x}$	V%	$\overline{x}$	V%	$\overline{x}$	V%
hell colour, % white Barwa skorupy, % bieli	58.7b	8.5	34.7a	14.0	59.1b	8.8
hell thickness, m rubość skorupy, m	326.9	7.2	318.5	7.8	311.9	8.7
hell density, mg cm ^{3} stość skorupy, mg cm ^{3}	74.5	9.3	76.0	11.0	69.9	15.3
hell strength, Wytrzymałość skorupy,	28.4	32.8	31.7	35.3	33.1	27.5
Egg shape inde , % ndeks kształtu, %	75.4A	2.8	77.3B	2.8	75.0A	2.9
hell proportion, % Udział skorupy, %	9.4A	7.1	10.3B	8.3	10.6B	10.7

A, B, C… values in lines with different letters differ significantly (P≤0.01).
A, B, C… wartości średnie cech oznaczone w wierszach różnymi literami różnią się statystycznie istotnie (P≤0,01).

Table 3. Selected egg quality traits from VH43, P55 and Z-11 hens at the age of 50 weeks
Tabela 3. Wybrane cechy jakościowe jaj kur VH43, P55 i Z-11 w wieku 50 tygodni

Trait Cecha	50th week of life 50. tydzień życia					
	VH43		*P55*		*Z-11*	
	$\overline{x}$	V%	$\overline{x}$	V%	$\overline{x}$	V%
Egg weight, g Masa jaja, g	68.9C	7.5	61.8B	7.0	56.0A	6.7
Albumen hight, mm Wysokość białka, mm	6.1	18.9	5.8	17.6	5.8	26.9
Haugh Units, HU Jednostki Haugha, HU	73.5	12.5	74.4	11.2	74.8	17.1
Yolk weight, g Masa żółtka, g	17.6B	7.7	16.7AB	8.8	16.4A	6.4
Yolk proportion, % Udział żółtka, %	25.7A	9.4	27.1A	7.6	29.4B	5.5
Yolk colour (la Roche) Barwa żółtka (la Roche)	5.5	20.3	4.4	34.1	5.2	22.2

A, B, C… values in lines with different letters differ significantly (P≤0.01).
A, B, C… wartości średnie cech oznaczone w wierszach różnymi literami różnią się statystycznie istotnie (P≤0,01).

Table 4. Selected traits of egg shell from VH43, P55 and Z-11 hens at the age of 50 weeks
Tabela 4. Wybrane cechy skorupy jaj kur VH43, P55 i Z-11 w wieku 50 tygodni

Trait Cecha	50th week of life 50. tydzień życia					
	VH43		*P55*		*Z-11*	
	$\overline{x}$	V%	$\overline{x}$	V%	$\overline{x}$	V%
hell colour, % white Barwa skorupy, % bieli	60.9B	9.9	35.7A	16.3	63.7B	6.5
hell thickness, m rubość skorupy, m	319.7	6.6	333.4	8.4	314.7	7.8
hell density, mg cm ^{3} stość skorupy, mg cm ^{3}	75.1	10.3	76.5	10.5	70.5	11.8
hell strength, Wytrzymałość skorupy,	26.1AB	40.6	29.9B	35.8	22.7A	28.0
Egg shape inde , % ndeks kształtu, %	73.8	2.5	73.8	3.3	74.8	3.7
hell proportion, % Udział skorupy, %	9.1	8.3	9.6	8.3	9.4	7.4

A, B, C… values in lines with different letters differ significantly (P≤0.01).
A, B, C… wartości średnie cech oznaczone w wierszach różnymi literami różnią się statystycznie istotnie (P≤0,01).

Statistically significant difference in the eggshell color was found between the P55 hens and the two remaining groups i.e. VH43 and Z-11. This difference was visible during the whole period of experiment duration. Irrespective of age, no significant differences in the thickness and density of shell in all the examined groups were found. However, the shape index of eggs from Barred Plymouth Rock (P55) hens at the beginning of laying, i.e. at 26th weeks of age, was significantly greater than that of the eggs from the VH43 crossbreds and Partridge Greenleg (Z-11).

The results of the study showed that there are differences in the physical traits of eggs obtained from hens of different origin being in various periods of laying. The literature data indicate the existence of many factors affecting the morphological composition and quality of eggs such as: bird's origin (species, breed, strain), age, nutrition, environmental conditions [Kokoszyński et al. 2007]. The effect of feeding on the weight of eggs, deformations, shape index and the shell thickness was reported by Solomon [2001]. The research showed that the largest eggs were laid by the crossbred VH43 hens both at 26 weeks of age and in the second examined laying period (50th weeks of age). According to Romanov [1995], the egg weight depends on genetic factors. Also environmental factors, and mainly thermal conditions and feeding, affect egg weight [Brzóska at al. 2000]. The results obtained by Sokołowicz and Krawczyk [2004 a] indicate age of hens as a factor affecting egg weight. The obtained results confirm that the eggs from young hens were smaller than eggs obtained at the end of laying. Czaja and Gornowicz [2006] investigated the effect of genome and age of hens on the quality of table eggs obtained from hens from the nine commercial flocks. They found that the eggs from the earlier laying period were

characterized by significantly higher values of Haugh units and albumen height. According to these authors, Haugh unit is the basic evaluation criterion of egg quality used on the international market. In the conducted research, similar relationship was observed. The highest value of Haugh units and albumen height were found in the eggs from the P55 hens at 26 weeks of age laying eggs with dark shells. The higher value of Haugh units which are used for the evaluation of albumen consistency and are closely correlated with the logarithm of albumen height corrected for egg weight [Bell et al. 2002] as well as greater albumen height of eggs from the initial stage of laying may prove their more favorable traits. According to Świerczewska [1997], eggs with white shell are characterized by significantly higher quality of albumen both in terms of its height and Haugh units. In the present study, this was not confirmed. In the conducted research, the age of layers influenced the quality of egg albumen. According to Michalak and Mróz [2003 a], its quality deteriorates with increasing hens' age, which was also observed in the present study. Eggs with darker, golden-orange color of yolks are more preferred by consumers [Krawczyk et al. 2005]. Such a color is particularly valued by consumers who think that eggs with intensely colored yolks contain more vitamin A compared to those with light-colored yolks. It is a misconception since xanthophylls, mainly lutein and reaxanthin, do not have the character of provitamin A [Świerczewska et al. 1999]. The color of egg yolk is mainly influenced by the content of total xanthophylls and other carotenoids that can be found in the green forage and dried grass and in maize [Zgłobica et al. 1995, Kuchta et al. 1997]. Czaja and Gornowicz [2006] found lighter color of yolk in eggs from commercial layers after the peak of the laying season, expressed in La Roche units, which was also observed in the eggs from the VH43, P55 and Z-11 hens from the second analyzed laying period. The percentage of yolk in the total egg weight is of great importance to the consumer due to the nutritional value and palatability. Selection for the egg weight increases the albumen weight to a larger extent compared to the yolk weight, which is caused by the stronger genetic correlation [Washburn 1990]. So, the significantly higher percentage of yolk in the eggs from the non-selected Z-11 hens, which is also one of the distinctive features of this breed, is understandable [Cywa-Benko et al. 2003, Krawczyk 2009]. One of the most important external traits of hens' eggs is the quality of shell [Sokołowicz and Krawczyk 2004 b, Kamińska and Skraba 1992]. The quality of eggshell is affected by genetic factors, ambient temperature, nutrition, and health of the layers [Roland and Bryand 2000]. Both in the first and the second analyzed laying period, no significant differences in the density, thickness and breaking strength of eggshell were found, although the shells differed statistically significantly with respect to the shell color during the whole period of experiment. According to Michalak and Mróz [2003 b], the brown eggshells are thicker than the white shells. The egg shape index of the P55 hens obtained at 26 weeks of age was significantly higher than that of the two remaining groups. No decrease in the pigment intensity of the eggshells from aging hens nor the change in the mean values of the egg shape index were observed in contrast with the results obtained by Sokołowicz and Krawczyk [2004 a]. The exhaustion of the eggshell pigment may be associated with age but only in some genetic groups [Michalak and Mróz 2003 b]. The observed significantly darker eggshell of the P55 hens compared to the two remaining groups allows to conclude that they are more

popular among the native consumers seeking for eggs with intensive dark-brown color of the shell [Świerczewska 1997].

CONCLUSIONS

Summarizing the conducted research, it can be concluded that the eggs obtained from hens from the Polish pedigree farms intended for rearing on small-scale farms (VH43 and P55) as well as from the breed of hens included in the poultry genetic resources preservation program (Z-11) differ in some significant traits. Also the age of layers affected the selected qualitative traits. During the whole period of experiment, the largest eggs were laid by the VH43 crossbreds. The darkest eggshells were observed in the P55 hens during the whole course of laying. Therefore, such eggs may be more popular among consumers preferring brown-colored shells. The highest value of Haugh units and albumen height were also found in the eggs from the P55 hens at 26 weeks of age. However, despite the fact that the Z-11 eggs had the lowest weight, they had also the highest percentage of yolk.

The study was carried out as a part of the research project BW-2221/KHDZFiZ/10.

REFERENCES

Andres K., Lis M., Niedziółka J., 2004. Effect of body weight and age of hens on hatch results of subcarpatian native fowls from farm household flock [Wpływ masy ciała i wieku na wyniki lęgów kur z chowu drobnostadnego z terenu Podkarpacia]. Zesz. Nauk. AR Wrocław 505, 36–40 [in Polish].

Bell D.D., Weaver W.D., North M.O., 2002. Commercial chicken meat and egg production. 5th ed. Springer Publishers, New York.

Brzóska F., Koreleski J., Herbut E., 2000. Environment and the quality of food of animal origin [Środowisko a jakość produktów pochodzenia zwierzęcego]. Rocz. Nauk. Zootech. 4 (Suppl.), 17–61 [in Polish].

Calik J., Krawczyk J., 2006. Role and importance of local breeds of laying hens included in the conservation programme [Rola i znaczenie lokalnych ras kur nieśnych oraz podstawowe wymogi programu ich ochrony]. Wiad. Zootech. XLIV (4), 28–33 [in Polish].

Cerolini S., Madeddu M., Zaniboni L., Cassinelli C., Mangiagalli M.G., Marelli S.P., 2010. Breeding performance in the Italian chicken breed Mericanel Della Brianza. Italian J. Anim. Sci. 9, 382–385.

Cywa-Benko K., Krawczyk J., Wężyk S., 2003. Quality of table eggs from hens of native breeds [Jakość jaj spożywczych pozyskiwanych od kur ras rodzimych]. Rocz. Nauk. Zootech. 30 (2), 405–413 [in Polish].

Czaja L., Gornowicz E., 2006. Effect of genome and hen's age on table egg quality [Wpływ genomu oraz wieku kur na jakość jaj spożywczych]. Rocz. Nauk. Zootech. 33 (1), 59–70 [in Polish].

Frątczak M., Józefiak D., Rutkowski A., Rosiński A., 2002. Red Label – original concept of poultry production in harmony with nature and humans [Label Rouge – oryginalna koncepcja produkcji drobiu w zgodzie z naturą i człowiekiem]. Pol. Drobiar. 6, 4–7 [in Polish].

Hoffmann I., 2005. Research and investment in poultry genetic resources – challenges and options for sustainable use. World Poult. Sci. J. 61, 57–70.

Kamińska B., Skraba B., 1992. Changes in egg shell quality during the first year of laying in hens. J. Anim. Feed. Sci. 1, 51–58.

Kokoszyński D., Korytkowska H., Korytkowski B., 2007. Evaluation of physical traits and morphological composition of Peking duck eggs from P44 reserve flock [Ocena cech fizycznych i składu morfologicznego jaj kaczek Pekin ze stada rezerwowego P44]. Acta Sci. Pol., Zootech. 6 (2), 21–28 [in Polish].

Krawczyk J., Wężyk S., Połtowicz K., Cywa-Benko K., Calik J., Fijał J., 2005. Effect of management system of hens of native breeds on egg quality in the initial period of egg production [Wpływ systemów utrzymania kur ras rodzimych na jakość jaj w początkowym okresie nieśności]. Rocz. Nauk. Zootech. 32 (1), 129–140 [in Polish].

Krawczyk J., 2009. Quality of eggs from Polish native Greenleg Partridge chicken-hens maintained in organic *vs*. back yard production systems. Anim. Sci. Pap. Rep. 27 (3), 227–235.

Kuchta M., Koreleski J., Młodkowski M., Zegarek Z., 1997 . Effect of dried grass and dried lucerne on egg quality and production indices in hens [Wpływ suszu z traw i suszu z lucerny na jakość jaja oraz wskaźniki produkcyjne u kur]. Rocz. Nauk. Zootech. 24 (1), 215–228 [in Polish].

Michalak K., Mróz E., 2003 a. Egg albumen quality [Jakość białka jaja]. Pol. Drobiar. 4, 9–10 [in Polish].

Michalak K., Mróz E., 2003 b. Egg shell quality [Jakość skorupy jaja]. Pol. Drobiar. 5, 9–12 [in Polish].

Roland D.A., Bryant M., 2000. Nutrition and feeding for optimum egg shell quality. XXI Worlds Poultry Congress, Montreal, Canada, 20–24 September, 1.

Romanov M.N., 1995. Qualitative and quantitative egg characteristics in laying hens of different genotype. VI European Symposium on the Quality of Eggs and Egg Products. 25–29 September, Zaragoza, Spain, 203–206.

Sokołowicz Z., Krawczyk J., 2004 a. The influence of layers' age and stocking density on egg quality [Wpływ wieku kur i wielkości obsady na jakość jaj spożywczych]. Rocz. Nauk. Zootech. 31(1), 103–113 [in Polish].

Sokołowicz Z., Krawczyk J., 2004 b. Quality of table eggs from hens in the first and second year of production [Jakość jaj spożywczych uzyskanych od kur w pierwszym i drugim roku użytkowania]. Rocz. Nauk. Zootech. 31 (2), 243–249 [in Polish].

Solomon S.E., 2001. Feeding for eggshell quality. IX European Symposium on the Quality of Egg and Egg Products. Turkey, 131–137.

Świerczewska E., Wężyk S., Horbańczuk J., 1999. Poultry husbandry [Chów drobiu]. Oficyna Wydawnicza „Hoża", Warszawa [in Polish].

Świerczewska E., 1997. White or brown? [Białe czy brązowe?]. Pol. Drob. 11, 12 [in Polish].

Trziszka T., 2000. Egg: science, technology and practice [Jajczarstwo: nauka, technologia, praktyka]. Ed. T. Trziszka. Wydaw. AR, Wrocław [in Polish].

Washburn K.W., 1990. Genetic variation in egg composition [in: Poultry Breeding and Genetics]. Ed. R.D. Crawford, Elsevier, 781–798, New York.

Wężyk S., 2000. Genetics and the quality of eggs and poultry meat [Genetyka a jakość jaj i mięsa drobiowego]. Rocz. Nauk. Zootech. 4 (Suppl.), 83–92 [in Polish].

Zgłobica A., Cywa-Benko K., Wężyk S., 1995. The effect of adding vegetable extracts to hen feed on egg quality and layers performance. VI European Symposium on the Quality of Eggs and Egg Products. Zaragoza, 251–256.

JAKOŚĆ JAJ KUR TYPU OGÓLNOUŻYTKOWEGO PRZEZNACZONYCH DO CHOWU DROBNOTOWAROWEGO

Streszczenie. Celem badań była ocena wybranych cech jakości jaj pochodzących od kur z polskich ferm zarodowych przeznaczonych do chowu drobnotowarowego oraz od rasy kur objętej programem ochrony zasobów genetycznych drobiu. Materiał do badań stanowiły jaja kur Barred Plymouth Rock (P55), mieszańców VH43 oraz jaja Zielononóżki kuropatwianej (Z-11). Masa jaja kur mieszańców VH43 na początku nieśności wynosiła 61,5 g i była istotnie większa niż masa jaj kur P55 (50,2 g) i kur Z-11 (42 g). Nie stwierdzono istotnych różnic w grubości i gęstości skorupy. Zanotowano statystycznie istotną różnicę w barwie skorupy jaj między kurami P55 a dwiema pozostałymi grupami. Największą wartość jednostek Haugha (99,9) oraz wysokości białka (9,7 mm) stwierdzono w jajach kur P55 w 26. tygodniu życia. Wartości te obniżały się wraz z przebiegiem nieśności w jajach wszystkich grup genetycznych. Największy procentowy udział żółtka stwierdzono w jajach kur Z-11 (29,5). Udział żółtka wzrastał wraz z wiekiem u wszystkich badanych grup, natomiast wskaźnik barwy żółtka (La Roche) zmniejszał się.

Słowa kluczowe: jakość jaj, krajowe rody kur

Accepted for print – Zaakceptowano do druku: 3.02.2011