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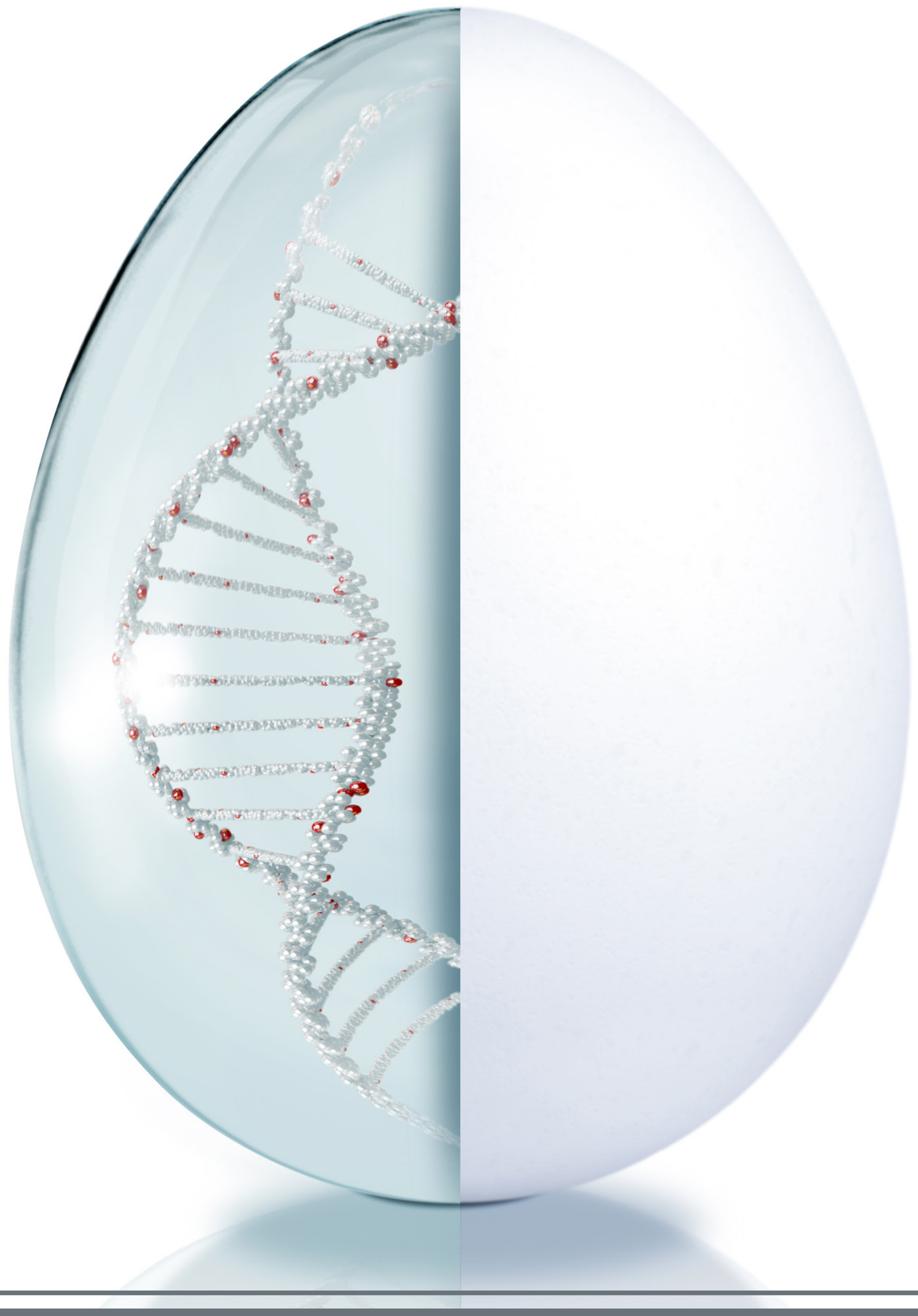

LOHMANN INFORMATION

Scientific publication of LOHMANN TIERZUCHT

BREEDING FOR SUCCESS … TOGETHER

LOHMANN TIERZUCHT

Contents

Dear colleagues and friends,

This is to announce a change in the editorship of Lohmann Information. With the publication of Vol. 50(1) 2015 I was introduced by Dietmar Flock as co-editor. It was agreed that I should take his position after an appropriate time of transition. After three years as co-editor the time has come that I take the responsibility as editor–in-chief. I would like to thank Dietmar Flock for having introduced me in all operating procedures. I would also like to thank the managing director Javier Ramirez as well as the editorial board for their assistance.

Lohmann Information has developed from a journal of the Lohmann Group and was mainly addressed to customers of the company towards an international scientific journal. Dietmar Flock has supported Lohmann Information as author of 57 articles from 1969 onwards. Under his editorship there were important changes. In a first step the transition from German towards the English language was completed. The second important step was the introduction of the online version. Finally the articles from 1979 onwards have been made available in the Lohmann Information Archive. It was the hard work of Dietmar Flock and his predecessors which granted the long-term existence of the journal.

During recent years the landscape of scientific publication was subject to a rapid development. The number of new online journals is increasing progressively. But not all of them are trustworthy. A recent investigation of journalists of distinguished newspapers (The Gardien, Süddeutsche Zeitung) and German broadcast companies have shown that "predatory" open-access publishers release articles without regular checks of the reliability. For a certain fee these journals allow the publication of anything. And recently even a journalist of the renowned German journal "Der Spiegel" has published "faked" articles. The frontiers between facts ad fakes have become blurred.

In scientific publications uncontrolled information not only misleads the readership but also undermines the trust in science generally. Established publishers claim that their editorial board and peer review system is an efficient instrument to prevent publication of doubtful results. On the other hand this system has been criticized to be slow and precluding authors from publication of new ideas which may range outside the mainstream.

Lohmann Information has an editorial board but does not have a classic peer review system. But Lohmann Information accepts articles only from distinguished authors which are known to the editor or a member of the editorial board. All manuscripts are thoroughly checked by editors with the required background of the subject. On this basis we will continue to provide you with interesting and unbiased information.

The present issue contains a broad variety of subjects: Development of egg production in Europe since the ban of conventional cages, internal egg quality, autogenous veterinary vaccines and production and management of ostriches.

The next issue will focus on the welfare aspects in layers, broiler and turkeys.

Werner Bessei

Prof. Hans-Wilhelm Windhorst

The author is Prof. Emeritus and Scientific Director of the Science and Information Centre Sustainable Poultry Production (WING), University of Vechta, Germany.

EU egg production since the exit from conventional cages: housing systems affect the volume of production

Abstract

Within five years after banning conventional cages for laying hens in the EU, the situation has stabilized and egg production exceeds the demand. This report shows the current egg production in the 28 countries, based on recent reports of the Committee for the Common Organisation of the Agricultural Market for Eggs.

Keywords

EU, egg production, housing systems

Housing systems in EU laying hen husbandry

In 2016, 384 Mio laying hens were kept in EU member countries. Table 1 and figure 1 document the share of the four housing systems which are used presently. Enriched cages are the dominating housing system with a share of 55.6%, followed by barn and free range systems. The share of organic egg production is still very low with a share of only 4.6 %.

Table 1. Housing systems in EU laying hen husbandry in 2016 (Source: EU Committee 2017)

Housing system	Laying hens (Mio)	Share (%)
Enriched cages	213.476	55.6
Barn	98.544	25.7
Free range	54.309	14.1
Organic	17.738	4.6
Total	384.068	100.0

The regional concentration of laying hen husbandry in the EU is quite high. The 10 member countries with the largest hen population shared 86.1 % of the total inventory (Table 2). Germany was in a leading position with 52.6 Mio hens, followed by France, Spain and Poland. These four countries contributed 48.8% to the EU laying hen population, the leading seven countries 70.9 %. The laying hen inventory reflects the number of inhabitants.

In table 3, the five member countries with the highest hen inventory in each housing system are documented. A comparison reveals significant differences between these countries. The number of laying hens in enriched cages was highest in Spain and Poland. Germany and the Netherlands were leading in barn systems, the United Kingdom and Germany in free range laying hen husbandry. The highest number of laying hens in organic husbandry is found in Germany and France.

Table 2. The ten EU member countries with the highest laying hen inventories in 2016 (EU Committee 2017)

Country	Laying hens (Mio)	Share (%) in the EU laying hen flocks
Germany	52.580	13.7
France	48.598	12.7
Spain	43.612	11.4
Poland	43.474	11.3
United Kingdom	42.176	11.0
Italy	41.627	10.8
Netherlands	34.180	8.9
Romania	8.209	2.1
Portugal	8.192	2.1
Sweden	8.041	2.1
Top 10 countries	330.698	86.1
EU (28)	384.068	100.0

Table 3. The five countries with the highest number of laying hens in each housing system in 2016 (Source: MEG 2017)

Country	Laying hens (Mio)	Share (%)
	Enriched cages	
Spain	40.535	92.9
Poland	38.387	88.3
France	33.584	69.1
Italy	27.353	65.7
United Kingdom	16.599	39.4
	Barn systems	
Germany	32.628	62.1
Netherlands	20.923	74.6
Italy	12.166	29.2
Sweden	5.298	77.5
Austria	4.305	66.8
	Free range	
United Kingdom	22,284	52.8
Germany	9.302	17.7
France	8.832	18.2
Netherlands	5.291	15.5
Spain	1.756	4.0
	Organic	
Germany	5.566	10.6
France	3.500	7.2
Netherlands	1.833	5.4
Italy	1.366	3,3
Sweden	1.312	16.3

The highest share of enriched cages is found in Lithuania (95.6%) and Spain (92.9%), whereas Sweden (65.9%) and Austria (65.5%) were top ranking for barn systems. The United Kingdom (52.8%) and Ireland (40.5%) had the highest share of their laying hens in free range systems. Organic laying hen husbandry reached the highest share in Denmark (28.6%) and Sweden (16.3%).

Figure 2 documents the variation between the 28 EU member countries regarding the share of the four housing systems.

Patterns of egg production

Between 2012 and 2016, egg production in the EU increased by 6.1%, from 7.0 to 7.5 Mio t (Table 4). In response to the decision to phase out conventional cages in all EU member countries by 2012, investments in new facilities could not be realized in all countries in time. As a result, egg production initially dropped, then returned to and finally exceeded former production. Between 2012 and 2013, the production volume grew significantly by 3.6%; in the following years at a decreasing rate: 1.4% between 2013 and 2014, 1.0% between 2014 and 2015 and only 0.1% between 2015 and 2016.

Table 5 shows the top ten EU countries in egg production in 2016. Changes in ranking compared to Table 2 are interpreted as the result of differences in the share of housing systems in the member countries. France ranks in an unchallenged first place, followed by Germany, Spain and Italy. The regional concentration in egg production is rather high. The top ten countries produce 84.4% of the total EU egg production. With the exception of the Netherlands, the ranking in egg production reflects the human population in each country.

A projection of production and demand until 2025

In table 6, the development of production and demand is extrapolated from 2017 to to 2025.

Egg production in the EU currently exceeds consumption by about 5.0%. Unless the excess production can be exported either as shell eggs or as egg products, a lasting period of relatively low egg prices is expected. As a way out of this dilemma, more emphasis on added value of eggs and egg products is recommended.

Table 4. The development of egg production in the EU between 2012 and 2016 (Source: MEG 2017)

Year	Egg production (Mio t)	Index (2012 = 100)
2012	7.047	100.0
2013	7.303	103.6
2014	7.400	105.0
2015	7.470	106.0
2016	7.478	106.1

Table 5. The top ten countries in EU egg production in 2016 (Source: MEG 2017)

Country	Egg production (1,000 t)	Share (%) in EU production
France	953	12.7
Germany	881	11.8
Spain	866	11.6
Italy	840	11.2
United Kingdom	776	10.4
Netherlands	715	9.6
Poland	600	8.0
Romania	345	4.6
Belgium	176	2.4
Czech Republic	156	2.1
10 countries	6,308	84.4
EU	7,478	100.0

Table 6. Projected development of egg production and consumption in the EU between 2017 and 2025 (Source: EU Committee 2017)

Year	Production Mio t	Consumption Mio t	Surplus %
2017	7.762	7.391	5.0
2019	7.885	7.498	5.2
2021	8.010	7.607	5.3
2023	8.138	7.718	5.4
2025	8.270	7.831	5.6
Increase (%)	6.5	6.0	

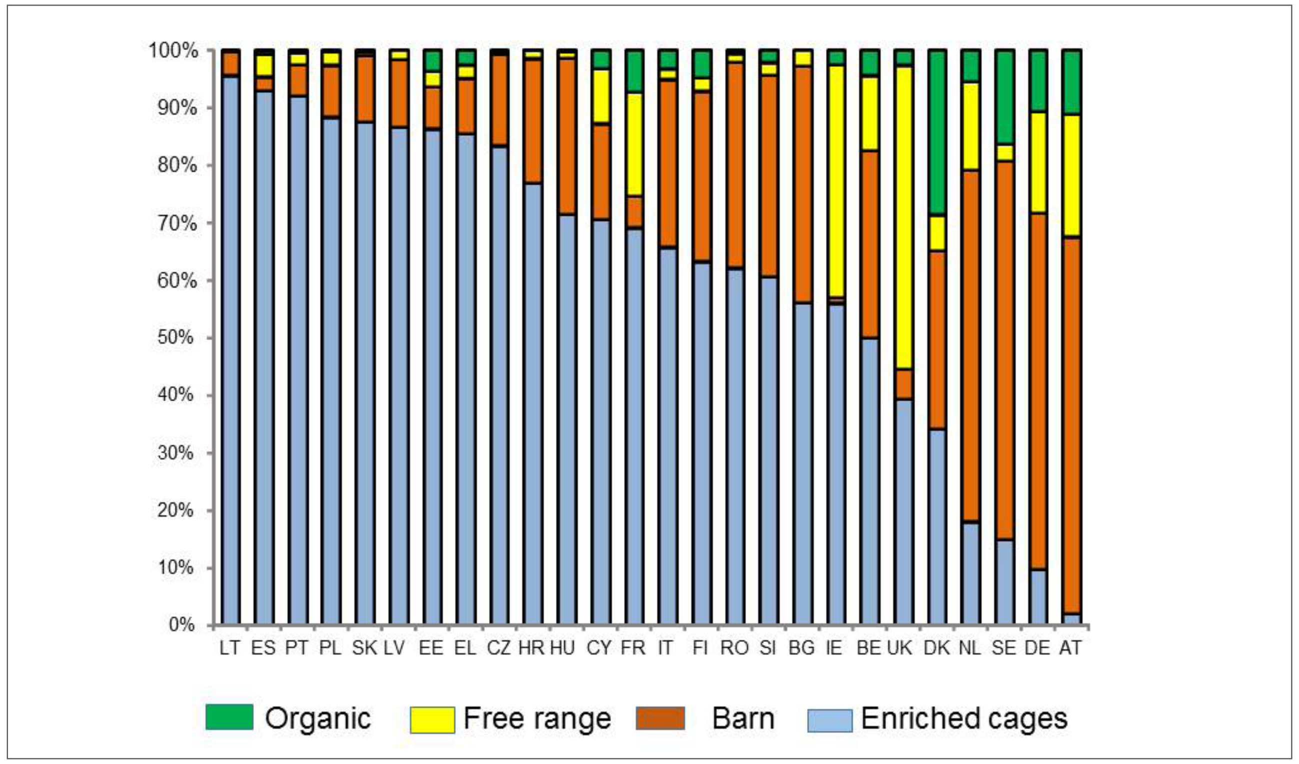

Figure 1. The share of housing systems in EU laying hen husbandry (EU Committee 2017)

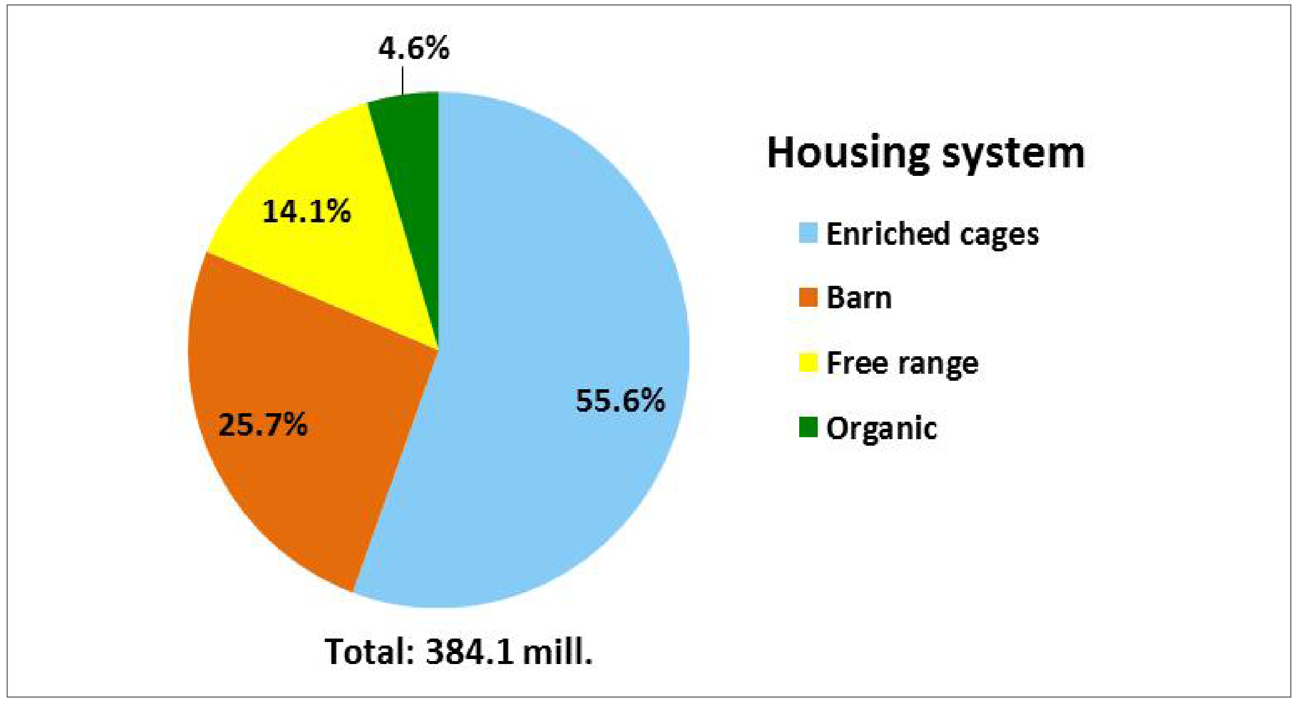

Figure 2. Housing systems in laying hen husbandry in the EU member countries (2016) (Source: MEG 2017)

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Dietmar K. Flock

Dr. Dietmar K. Flock contributed to the genetic improvement of egg quality in commercial white-egg and brown-egg strains. In this article he calls attention to causes of variation and possibilities to improve internal egg quality.

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Internal egg quality: trends and opportunities to respond to changing demand

Abstract

Global consumption of eggs continues to grow and is supported by a strong egg industry which combines contributions of specialists in breeding and genetics, poultry health, nutrition, farm technology, further processing and international trade to offer eggs and egg products year-round at competitive prices. Governments in many countries support human health with regulations for the production, marketing and traceability of eggs, while primary breeders and their distributors compete in terms of product quality and technical advice for efficient production of quality eggs adapted to local preferences. The genetic potential of different strains of laying hens varies and responds to selection. Genetic differences between commercial strain crosses may seem small compared to environmental effects such as bird health, feed composition, climatic conditions and flock age. However, the choice of the most suitable white-egg or brown-egg strain, in combination with up-to-date advice on feed composition, disease prevention and bird management, should help egg producers to maximize egg income from quality eggs adapted to regional and seasonal demand.

Keywords

laying hens, egg composition, internal egg quality, Haugh Units, blood spots, egg storage

Introduction

The evolution of human societies has a major effect on the co-evolution of animal and poultry farming. Senior people may remember farm life as described by Jimmy Carter (1975): "*fried chicken and chicken pie were often part of our regular meals, and there were hen nests located in every convenient place…wherever the hens had an inclination to lay eggs*". Until artificial lighting programs were introduced, egg production was seasonal: most chicks hatched in spring, grew up during the summer and went into a molt before a winter pause. Following annual cycles of supply and demand, fresh eggs were scarce and expensive during winter months, and it was helpful to know how to conserve eggs to bridge the supply gap. Nowadays fresh eggs are available year-round, and continuous utilization of farm facilities keeps the production cost low. Researchers at agricultural colleges and research institutions in North America and Europe became interested in egg quality after the rediscovery of Mendel's laws of inheritance and in response to commercial interest in egg production as a source of farm income.

Commercial egg producers are focused on egg income during the lifetime of a flock, and criteria of egg quality determine the sales value per egg. Geneticists collect and analyze individual data from pedigreed hens to estimate genetic parameters and calculate breeding values. Before eggs become available in food stores, they are graded twice: (1) on the farm, eggs with obvious defects are eliminated (floor eggs in non-cage systems, dirty eggs, broken shells); (2) in packing stations, eggs are sorted on weight, checked for cracked shells and candled for inclusions. Consumers may open the egg carton before purchase to verify that all eggs have intact shells and are individually stamped with management system, country of origin and farm code. State laboratories check farms and samples of eggs from stores to identify illegal residues in eggs, which may present temporary health risks (e.g. Fipronil found in 2017). Primary breeders compete worldwide with hybrid strain crosses primarily selected for efficient egg production and external egg quality criteria (egg size, shell strength and shell color). To benefit from the genetic potential for internal egg quality, egg producers can optimize feed composition and bird health throughout the laying cycle. Consumers in many countries pay increasing attention to the conditions under which eggs are produced (cage, barn, free range or organic system) and accept a higher price if the eggs come from a regional producer.

For many years, the standard reference on egg quality was Romanoff and Romanoff (1949). Ternes et al. (1994) published an update in German with new references. An advertisement of Lohman Tierzucht in this book read: "*Eggs are a perfect result of evolution - we are working on further improvements*". Today's active geneticists are still following this breeding goal in their index selection. In recent years, several new books have been published: Nys et al. (2011) and van Immerseel et al. (2011) in France; Roberts (2017) in Australia; Simons (2017) in The Netherlands; and Kashimoro (2017) in Japan. Everybody with a responsible position in the egg industry should be aware of these books and benefit from the latest knowledge about egg quality.

The following outline will focus on genetic variation and non-genetic factors affecting internal egg quality.

Egg size and egg composition

As described more than a century ago and analyzed in more detail in recent times, eggs have three main parts: shell, yolk and albumen. Consumers may have a preference for yolk color and enjoy the taste of a soft-boiled egg or the looks of fried eggs "sunny-side up". The yolk has more taste than the albumen, while the shell has important functions, but no nutritional value.

Natural selection in different species favored eggs with optimum size for hatchability and as survival package for the developing embryo. Surprising similarities (and differences) between bird species have been reported for the percentage of yolk across a wide range of egg weight and types of birds (**Table 1**).

The estimates for precocial species are of interest in the present context, because they refer to chickens before the onset of modern selection, when dual purpose breeds averaged less than 150 eggs per year. Eggs from water fowl have relatively more yolk than chicken and turkey eggs, while pigeons and other artricial species have a much lower yolk percentage. Visitors of New Zealand will learn that the state bird Kiwi lays only one extremely large egg (compared to body size) per year, with about 2/3 yolk and 1/3 albumen content.

Table 1: Egg composition in some precocial vs. altricial birds

Species	Egg weight (g)	Albumen (%)	Yolk (%)	Shell (%)
Precocial birds[a]				
Goose	200	52.5	35.1	12.4
Turkey	85	55.9	32.3	11.8
Duck	80	52.6	35.4	12.0
Chicken	58	55.8	31.9	12.3
Altricial birds[b]				
Golden eagle	140	78.6	12.0	9.4
Buzzard	60	76.8	14.0	9.2
Pigeon	17	74.0	17.9	8.1
Starling	7	78.6	14.3	7.1

[a] Romanoff and Romanoff (1949; [b] Sotherland and Rahn (1987)

[1] Based on an invited paper, presented at the EggMeat Symposium of the WPSA 2017 in Edinburgh

Breeders of commercial chickens monitor the variation between and within lines for all traits which may contribute to egg income and the genetic correlation between different traits has to be known and taken into account in an optimized selection index. Well known is the negative correlation between egg number and egg size, and we could show in a designed experiment that egg size in commercial layers would drop by 0.5 g per generation if egg size were ignored (Stöve-Schimmelpfennig and Flock, 1982).

Tharrington et al. (1999) compared the egg composition of a current commercial strain (H&N Nick Chick) with three Ottowa control strains and concluded that selection had produced larger eggs (63.9 vs. 58.6g) with more albumen (62.3 vs. 60.3%) and less yolk (28.5 vs. 30.6%), while overall egg quality had been maintained or improved.

Grashorn (2018) recently analyzed egg composition in a white-egg and a brown-egg strain during a full laying year (Table 2). The results show a consistent age effect in both strains (yolk percentage starts low and increases significantly until peak production). Compared to the figures published by Tharrington 20 years ago, the yolk percentage in today's commercial layers is only slightly lower during the second half of the laying period, but significantly lower for the whole laying period. The White Leghorn strain had a small, but consistent advantage in terms of yolk and shell percentage throughout the laying period.

Table 2. Egg composition of commercial laying hens (Grashorn, 2018)

	White eggs				Brown eggs			
4-week	Egg wt.	Albumen	Yolk	Shell	Egg wt.	Albumen	Yolk	Shell
period	g	%	%	%	g	%	%	%
1	51.1	67.4	22.4	10.4	52.8	68.0	22.2	9.8
2	56.6	65.6	24.5	9.9	59.7	66.7	23.8	9.5
3	59.1	64.1	25.6	10.3	60.4	65.3	24.8	9.9
4	60.0	63.1	26.8	10.1	62.8	64.2	26.2	9.6
5	60.9	63.1	26.8	10.1	61.7	64.0	26.2	9.8
6	62.1	62.7	27.4	9.9	65.3	62.9	27.4	9.7
7	62.4	63.2	26.9	9.9	64.3	63.3	27.2	9.5
8	63.3	62.2	28.0	9.8	65.0	63.0	27.4	9.6
9	63.4	62.0	28.2	9.8	66.4	63.6	26.9	9.5
10	65.6	62.3	28.2	9.5	66.7	63.5	27.1	9.4
11	63.2	62.7	27.7	9.6	66.7	63.8	26.6	9.6
12	64.2	62.5	28.1	9.4	65.5	63.4	27.0	9.6
13	65.7	62.5	28.1	9.4	66.6	64.0	27.0	9.0
Average	61.4	63.3	26.8	9.8	63.4	64.3	26.1	9.6

The reduction of yolk percentage during recent decades can be explained as the result of selection for more efficient conversion of feed into egg mass. Some consumers may prefer small eggs from young flocks to limit their energy intake, but the egg processing industry is more interested in yolk mass than albumen. Supply and demand for liquid whole egg, yolk and albumen determines the price of each product. Currently, liquid egg yolk is being sold to bakeries in Germany at a price of 4.90 Euro/kg, compared to 1.14 Euro/kg for liquid whole egg with 23% dry matter. Processing plants in countries with a strong egg processing industry prefer contract production of white-shelled eggs from large units rather than collecting non-salable eggs at minimal price from many smaller farms. The egg processing industry also needs fresh eggs of high internal quality to separate yolks from albumen. As recently reported by Grashorn et al. (2018), even small yolk impurities in the albumen significantly reduce the foam volume, while the foam durability is impaired. Using the combined effects of genetic potential for high yolk mass and nutrition can reduce the cost of liquid yolk mass, while local energy cost and freight rates determine the chance to export dried egg products.

Albumen quality: Freshness, Haugh Units

Egg albumen is of special interest in terms of global nutrition, because it can be produced in all parts of the world, with less environmental impact than e.g. meat from ruminants (Flachowski et al., 2017). To assure optimal albumen quality, table eggs should be collected at least once a day, cooled down to storage temperature and stored in the refrigerator at about 4 °C. Without cooling, the albumen quality deteriorates quickly, depending on storage conditions. Recommendations for optimal storage can be found in publications by Grashorn et al. (2016) and Simons (2017).

Freshness may be estimated in intact eggs by measuring the height of the air cell in candled eggs, but is more commonly reported in terms of albumen height, converted to Haugh Units. The conversion makes sense when egg quality is compared at different age of the hens. However, when primary breeders break eggs to determine internal egg quality in pedigree hens, the hens will be of similar age, and any bias in favor of larger eggs can be ignored, because it would be in a desirable direction. When measuring internal egg quality at the breeder farm, the number of eggs evaluated per hen will determine the accuracy of breeding value estimation.

Figure 1 shows the effects of storage conditions on Haugh Units.

Genetic differences between commercial strains in Haugh Units are small, compared to differences due to age of the hens, their health status, storage temperature and egg handling from oviposition to the measurement of albumen height.

The results in Table 3 from two recent random sample tests in Germany (involving the same two white-egg, two brown-egg strains and one tinted-egg strain; hatched 1 June 2016, eggs analyzed at the same age) show significant differences between the two stations across all five strains and declining Haugh Units with progressing age of the hens. Effects of specific environmental conditions (cage vs. floor management) on internal egg quality should be studied in more detail in future tests.

Figure 1. Linear regressions of Haugh Units (HU) in response to storage duration (days) and temperature (6. 15 and 22 °C) (Grashorn et al., 2016).

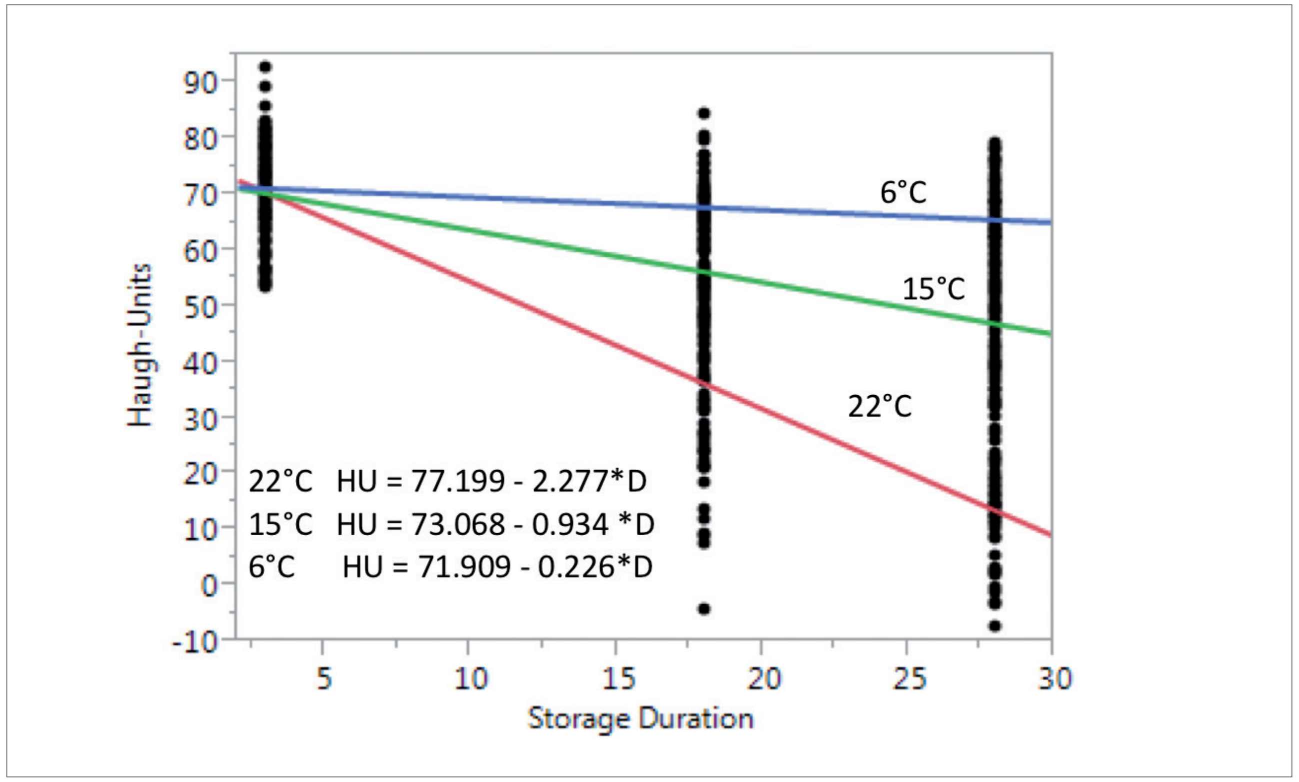

Table 3. Effects of strain, hen age and test station on Haugh Units

Station	Age	LB	NB	DW	LSL	Sandy	Average
Haus Düsse	42 wks	95.5	90.2	96.2	96.6	96.2	94.9
	58 wks	92.9	82.9	94.8	93.3	91.6	91.1
	68 wks	89.8	85.1	92.0	89.3	88.4	88.9
	Average	**92.7**	**86.1**	**94.3**	**93.1**	**92.1**	**91.7**
Kitzingen	42 wks	89.5	87.4	91.5	91.0	89.4	89.8
	58 wks	84.0	81.4	87.4	86.8	84.2	84.8
	68 wks	84.1	81.7	86.0	86.7	82.9	84.3
	Average	**85.9**	**83.5**	**88.3**	**88.2**	**85.5**	**86.3**

Inclusions: Blood Spots and Meat Spots

Brown-shelled eggs sometimes include spots of variable size and color, called "blood spots" or "meat spots". Consumers will seldom find them in white-shelled eggs, but complain if they find an unusual frequency of large inclusions in brown-shelled eggs. Genetic disposition is obviously involved, as shown again in two recent random sample tests in Germany. The results in Table 4 confirm the expected difference between brown-egg strains (LB, NB) compared to White Leghorn strains (DW, LSL), while the cross between brown-egg and white-egg parent strains (Sandy) has an intermediate frequency of blood and meat spots under the same environmental conditions. The consistent difference between stations and the apparent increase with age of the hens suggests that non-genetic effects (most likely feed composition) are important.

Table 4. Effects of strain, age and testing station on inclusion rate (%)

Station	Age	LB	NB	DW	LSL	Sandy	Average
Haus Düsse	42 wks	6.0	6.0	0.0	0.0	7.0	3.8
	58 wks	10.0	7.0	0.0	0.0	6.0	4.6
	68 wks	9.0	9.0	0.0	0.0	1.0	3.8
	Average	**8.3**	**7.3**	**0.0**	**0.0**	**4.7**	**4.1**
Kitzingen	42 wks	13.8	11.5	0.5	1.0	8.5	7.1
	58 wks	18.5	16.5	0.0	0.5	13.0	9.7
	68 wks	23.8	22.5	0.0	0.0	14.5	12.2
	Average	**18.7**	**16.8**	**0.2**	**0.5**	**12.0**	**9.6**

Both German testing stations report "inclusions" of at least 3mm, without specifying the difference between blood and meat spots. The published reports contain no explanation for the obvious difference between stations, and the question remains for future tests in Kitzingen whether specific causes of increased frequency of blood or meat spots can be identified. For example, the quality and inclusion rate of critical feed components may vary between seasons and age of the hens. Another question is whether the floor management in Kitzingen causes more unrest during the time of ovulation than in the enriched cage system in Haus Düsse.

Considerably lower frequencies of blood spots have been documented in random sample tests at Ustrasice in the Czech Republic, without specifying the size and differentiating between blood and meat spots. In Table 5 the frequency of blood spots in three 4-week laying periods is summarized for 10 brown-egg strains which participated in three consecutive tests. The frequency varies significantly between years and even between months of the same year, compared to rather small differences among the 10 brown-egg strains which participated in all three tests.

Table 5. Effects of strain, age and year on inclusions (%) in random sample test Ustrasice

	2014-15			2015-16			2016-17				
Strain	**LP 6**	**LP 9**	**LP 12**	**LP 6**	**LP 9**	**LP 12**	**LP 6**	**LP 9**	**LP 12**	**Mean**	**S.E.**
Hy-Line Brown	0	1	2	7	2	2	1	0	0	1,7	0,7
H&N Brown Nick	0	2	2	8	2	10	3	0	0	3,0	1,2
ISA Brown	0	7	3	4	1	11	2	0	0	3,1	1,3
Novogen Lite	2	3	9	8	0	4	2	0	0	3,1	1,1
Bovans Brown	0	5	9	9	2	4	0	0	0	3,2	1,3
LB Classic	1	3	5	10	3	6	4	0	0	3,6	1,2
Hisex Brown	0	1	6	12	4	8	3	0	0	3,8	1,4
LB Lite	2	2	9	14	0	9	2	0	0	4,2	1,7
Novogen Brown CL	2	6	9	9	3	9	2	1	0	4,6	1,2
Lohmann Tradition	0	6	5	16	8	13	2	0	0	5,6	2,0
Average	0,7	3,6	5,9	9,7	2,5	7,6	2,1	0,1	0,0	3,6	1,2

Management standards for laying hens include recommendations for feed composition, which should help nutritionists to formulate balanced rations to minimize the risk of blood spots in brown-shelled eggs and to exclude critical components in case of problems. Egg producers who use superior egg quality as a marketing argument for their eggs should buy feed with assurance from the supplier that no components are used which may cause off-flavor. The smell of the feed on delivery can be used as a quality criterion, and keeping a sample of feed from each delivery for analysis in case of consumer complaints is common practice. Fishmeal of good quality has no negative effects on the taste of eggs, but rancid oil should be excluded.

Fifty years ago, when I started to work as geneticist in the H&N team, I learned a lot about egg quality from the literature and analyzed pedigree data to determine how to improve egg quality. Researchers at the University of California had used selection for high vs. low blood spot frequency in an experimental line to demonstrate how genetic theory works in practice: Starting with low frequency at the beginning of the experiment, they were able to increase the frequency significantly within a few generations (high intensity of selection for a rare trait), whereas no progress was achieved in the desired direction of fewer blood spots. When I last analyzed large volumes of pedigree records in the White Leghorn lines of Lohmann Tierzucht, the calculated "repeatability" was negative, because most hens laid all eggs without inclusions and only a few hens laid a single egg with a small blood spot.

For brown-egg breeders, it is standard practice to collect pedigree data on blood spots and to select against this undesirable trait, and we may ask why primary breeders have not been able to reduce the frequency of inclusions. It seems reasonable to suspect that shell color has something to do with the incidence of inclusions, but I am not aware of published scientific results to verify this and therefore asked for unpublished data. Table 6 shows recent estimates of genetic parameters from 7 brown-egg lines, some of which are commercially used, while others are experimental lines presently being tested for special markets. When samples of eggs are broken from pedigree hens before selection to determine internal egg quality, blood and meat spots are scored for inclusions on a scale from 1 (no spot) to 9 (large blood or meat spots), corresponding to the anticipated response of consumers if they find inclusions in eggs.

Table 6. Genetic parameters of shell color (L-a-b) and inclusion score (1 = very large, 9 = none) in different brown-egg lines (Schmutz, 2018)

	Heritability		Genetic correlations with inclusion score		
Line Code	L-a-b	Incl. Score	L	a	b
A	0.57	0.17	0.23	-0.18	-0.28
B	0.45	0.14	0.28	-0.27	-0.32
C	0.30	0.25	0.19	-0.16	-0.08
D	0.57	0.26	0.21	-0.19	0.01
E	0.53	0.08	0.09	-0.12	0.03
F	0.48	0.14	0.21	-0.18	-0.01
G	0.56	0.13	0.13	-0.15	-0.13
Average	0.49	0.17	0.19	-0.18	-0.11

The heritability of inclusion score is low (h^2 = 0.17) compared to the heritability of shell color (h^2 = 0.49), and all three parameters of shell color are correlated in an undesirable direction with inclusion score. Simultaneous improvement of negatively correlated traits is not impossible, but genetic progress will be slow. To assure that the incidence of inclusions will not increase and hopefully decrease, more eggs per hen would have to be scored for inclusions to increase the accuracy of breeding value estimation

Organoleptic evaluation of egg quality

My interest in the taste of eggs started in the 1970s, when I was responsible for the HNL White Leghorns breeding program of Lohmann under license from H&N. White-shelled eggs had dominated the German egg market for many years, while brown-egg strains were gradually increasing their market share. In a market oversupplied with white eggs, affluent consumers turned to the more expensive brown eggs, assuming that these eggs taste better, because they are from happier hens, kept under natural conditions with access to free range.

To test this hypothesis, we offered farm employees boiled eggs during the coffee break and asked them to score the odor and taste of the eggs. The eggs were from caged white-egg and brown-egg hens on the same feed, peeled to exclude any bias due to shell color. Instead of finding a better taste for eggs from brown-egg strains, a few eggs were noted as having a "fishy" smell, which excluded them from being tasted. We learned that people differ remarkably in their sensitivity to off-flavor, and some people even commented the "fishy taint" as "normal" in farm eggs. The same inability of some people to detect off-flavor can be observed in other situations, e.g. with rancid butter or corky wines. Some people still think that fishmeal in layer rations causes "fishy taint", but fishmeal of good quality does not cause fishy flavor of eggs, and fishmeal has been eliminated from commercial layer feed in the EU. When rapeseed meal was identified as a possible cause of tainted eggs, nutritionists focused on the quality of the component and limited the inclusion rate in feed for brown-egg layers.

For many years brown-egg breeders had been selecting against off-flavor, without knowing whether the cause was a dominant or recessive gene. A break-through came with the introduction of molecular genetics, after researchers in Finland identified a recessive gene which blocks the metabolism of trimethylamine (Honkatukia et al. 2005, Wolc 2017). Primary breeders could then identify not only homozygous, but also heterozygous carriers and eliminate this undesirable gene from their pedigree base lines.

While the problem of "fishy taint" in eggs from commercial brown-egg layers may seem solved, feed companies must remain aware of the fact that some feed components can affect the taste of eggs, especially when used at excessive levels to reduce the feed price. Whenever possible, nutrition experiments involving critical components should include a taste panel to evaluate possible effects on internal egg quality (Damme, 2017).

Finally, it would be interesting to find out to what extent trained people are actually able to taste the effect of air quality during a major part of the day, which could then be used as a criterion to assess the birds' wellbeing.

Changing patterns of egg consumption

Today's commercial laying hens are bred to lay an egg almost daily throughout an extended lifecycle, while many affluent urban consumers have become "flexitarians" who may or may not include eggs in their breakfast, fast food for lunch or dinner parties. The best way to promote egg consumption is to assure consistent top quality at a fair price. Instead of unwarranted warning that eggs may cause disease problems, children should learn about food safety and hard boiled eggs from healthy flocks should be offered in schools in support of balanced nutrition, especially in developing countries.

Conclusions

Worldwide egg production has increased since several decades, faster than the human population grows. While primary breeders continue to monitor all egg quality parameters which contribute to a more sustainable egg business, nutritionists need to learn more about effects of critical feed components on egg taste. Egg processors may benefit from taking known differences between strains into consideration when renewing contracts with egg producers. Consumers could benefit from information with each egg purchase, including recommendations how to maintain egg quality and prepare delicate meals from top quality eggs.

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Ostrich production today: the (eco)logical way to economic success

Abstract

As a relatively young branch of agriculture, ostrich farming still requires substantial research concerning farming and especially feeding methods. A study conducted by "artgerecht e.V", the German Association of professional ostrich farmers as well as its sister association Bundesverband Deutscher Straußenzüchter compared the production costs and meat yield of different management and feeding systems: On the one hand intensive "fattening" of large numbers of birds on limited open space with a strong tendency to indoor keeping for most part of the year, on the other hand an all-year- extensive outdoor browsing with only moderate supplementary feeding. The results show without any doubt that only an ecological and extensive system of ostrich farming can lead to economic success: Competitive product prices mostly depend on costs of production, and low cost can only be reached by making best use of the ostriches' extraordinary utilization of fiber-rich feedstuffs. Further, since customers today show increasing interest in animal welfare and ask for respective products and quality labels, an ecological farming system will increase the acceptance by the consumer and will ultimately ensure the success of the business. International developments within the ostrich branch confirm the study's conclusions: Ostrich farms in arid regions as well farms using intensive feeding in areas with lush vegetation either struggle for economic survival or have disappeared altogether.

Introduction

Many differing, even contradictory methods of keeping and raising ostriches are being practised and propagated on farms around the globe. In South Africa the majority of ostriches is kept on steppe soil or semi deserts with poor vegetation and is fed with farm grown products or with commercially produced feed. „Browsing" is seldom possible and does not play a role in the farmers' business calculations.

In Southern Europe, Turkey or Greece as well as in all eastern European countries large numbers of birds are kept on very limited space - even in shelters heated in winter nights or for several months - and fed almost exclusively with commercially produced feed. Pasture here also hardly plays a role. The same applies to the ambitious new farming nations such as Iran, Pakistan or the People's Republic of China.

In central Europe, however, professional farms make use of the ostrich's extremely high capacity to digest fiber and to convert it into growth: They keep their birds on large pastures all year and supplement at maximum 1/3rd of the daily feed consumption with a farm-specific mixture or with commercially produced ostrich feed. But the available grassland for such ecological ostrich farming is scarce in all member states of the European Union as well as in Switzerland, therefore these farms still are the minority. However, the new standards issued by the German Department of Agriculture from now on ask for doubling of available space as well as for smaller group sizes.Thus, only farms with ample space will be able to operate economically in the future.

There are many different systems of farming and different views of adequate and economical feeding - and just as many differing reports of the expenditures for producing a slaughter bird. While the traditional ostrich producing countries in Africa, further Australia and a few European and American farms are able to bring up a slaughter birds for approximately € 250,00, businesses applying the intensive method for instance estimate just feed costs at € 300,00 per bird or even more.

High feed costs as well as high investment and operating costs for instance for expensive sturdy shelters have had a more than detrimental effect on the profit situation of these enterprises. Even in times when the leading ostrich producing country South Africa was banned from the European market, farms working with the intensive system reached no or only low margins.
The same applies to numerous farms in South Africa and Namibia, where commercial ostrich production during the last 15 years suffered from drastic losses or – in the case of Namibia – had to be suspended completely. The reasons are on the one hand long-lasting export bans following outbreaks of Avian Influenza but on the other hand high feed costs, which through lack of cheap forage made a competitive ostrich production impossible.

Even in the warmer regions of Europe ostrich farming has changed fundamentally. During the BSE crisis, when ostrich meat was sought after as a replacement of beef, the branch experienced an extraordinary boom. However, when the panic faded away, customers returned to beef, prices for ostrich meat dropped – often because neither supply nor quality lived up to the requirements of the market.

Diminishing returns on the one hand and high feed costs because of limited space and aridity on the other hand have led to an almost complete disappearance of ostrich farming in countries such as Italy or Spain. In 2000 Italy and Spain counted 4000 ostrich farms. Today only a handful is left in each country – more or less struggling at the edge of subsistence.

The described developments have caused a fundamental shift of importance of ostrich producing nations internationally: In the 20th century southern African countries were considered world leaders - today they hardly play a role. Even South Africa is clearly cut off compared to the actual leading producers.

The actual list of ostrich producing nations **(Table 1)** can only be a snapshot. Further shifts are to be expected, since the high feed costs in intensive systems threaten farms in all parts of the world. At present, producers in Pakistan, Saudi Arabia, the Emirates or Iran still achieve remarkable meat prices. However, their population numbers rise, and consequently a rise in feed costs and therefore in production costs is to be expected. Economic success will thus be reserved to the ostrich farmer who is able to use extensive pasture system – which will hardly be possible in the predominantly arid desert regions, for instance, in Iran **(Figure 1a,b,c)**.

Intensive ostrich production (a) is characterized by high stocking density and commercial pelleted feed; semi-intensive production (b) with limited pasture the birds a fed additional pelleted feed; extensive production systems (c) depend on well managed pasture as main feed base. Because of high costs of commercial feed, intensive production of ostriches is less economical than the semi-intensive (b) or extensive farming system (c).

a)

b)

c)

A critical analysis of the necessary expenditures for the production of birds for slaughter is more important than ever – and a helpful tool for present and future farm businesses. The following study aims at comparing costs and returns of different farming and feeding systems and at analysing the effects of the different systems on product quality as well as on consumer acceptance.

Table 1. Main ostrich producing countries: Numbers provided by producers. Official statistics are mostly not available.

Year	2018/ 2019	2010	2000
Overseas countries			
China	500000*	500000*	250000*
Brazil	250000*	450000*	0
South Africa	130000**	250000	300000
Pakistan	100000*	0	0
Iran	40000*	0	0
Arabian countries/ Emirates	25000*	0	0
Botswana	15000	0	0
New Zealand	15000	15000	10000
Australia	15000***	15000***	30000
Israel	0	1000	25000
Namibia	0	2000	25000
Zimbabwe	0	5000	55000
European countries			
Ukraine	50000****	1500*	0
Romania	10000	1000	0
Poland	3000	5000	0
Germany	2500	1750	1000
Portugal	2000	2000	2000
Hungary	1500	1000	0
France	1500	1500	500
Austria	1000	1000	500
Bulgaria	1000	0	0
Italy	1000	2000	5000
Spain	1000	1500	7000

* For home respectively regional market only, ** Temporarily banned for export, *** Export into the USA and Japan only, **** Not yet approved for EU

Methods

Between 2001 and 2015 a total of 463 birds for slaughter were monitored on six ostrich farms in Germany (Baden-Württemberg, Rheinland-Pfalz, Hessen, Brandenburg) and Poland (Region Gdansk). Two of these farms (group A) applied the extensive system, two (group B) the semi-intensive and (group C) the intensive system. All birds were Zimbabwe Blue or a similarly sized crossbreed. The study looks at production costs, at meat yield as well as at the acceptance of the different farming systems on the side of the customers.

Farming systems

Group A was raised under extensive farming conditions from day one to slaughter age. Up to the age of three months group size was 30 birds on green paddocks of 1000 to 3000 m². From the fourth month 15 birds were kept in paddocks of 5000 m². From day 4 onwards, all birds had access to pasture, starting at 20 minutes per day up to unlimited access (day 15 onwards). Up to the end of month 4 all birds were sheltered at night to protect them from predators. Starting at month five, the shelters remained open day and night, even during rain, snow and temperatures below freezing-point. Only chicks up to day five had a heated shelter. From day six to the end of week eight, heating was reduced to local floor heating (pads or water beds for piglets) at the spot where the chicks congregated for rest and sleep. Additional heating lamps from above were optional. After week 9 heating was no longer used, not even during periods of frost. The lowest outside temperature during the winter of 2010/2011 was -22,3 degrees Celsius.

Groups B and C were raised under extensive conditions until the birds were four weeks old. They were then moved to contracted farms and raised there semi-extensively and intensively up to slaughtering. Group size on farms B was 30 to 50 birds on paddocks of 2000 m² to 7000 m², depending on age. Farms in group C raised 10 to 12 birds on paddocks of appr. 600 m². A total of 127 group A birds were tested, 198 group B birds and 138 birds from group C.

Feeding

The main feed component of group A was browsing on pasture offering a variety of grasses, clovers and herbs (horse mixture plus white clover). This was supplemented by a ration consisting of maize, barley, wheat and wheat bran, soybean meal, sugar-beet pulp and a vitamin/mineral-premix, prepared fresh every day on the farm. The daily amount varied from 10 g to 1kg per bird, depending on age. The average daily ration of this supplement feed was 825 g from day 3 to slaughter. From October until mid April each group had an ad libitum supply of silage or chopped hay (particle length 2 cm to 5 cm).

Because of the high bird density and consequent lack of vegetation, the total intake of group B consisted of silage (58%) and the mentioned farm mixture of grains (42%). The complete ration had been composed and calculated by the feed company producing the premix, but it was frequently altered by the farmer - since he did not have all necessary components permanently available. The daily feed supply per bird was not determined by a set plan but by the farmer's decision. It ranged from 1100 g to 5000 g depending on age - on average 3800 g per bird and day from month three up to slaughter.

Group C was exclusively fed with pelleted feed produced from the farmers' own products. The daily supply ranged from 1.030 g to 3000 g depending on age and averaged 2.620 g of pellets and 1 kg of hay.

Costs of feed and pasture

The annual costs of pasture (land) were calculated at € 300.00 per hectare. This amounts to € 12.00 per bird in group A (25 animals/ha on average).

- Group B: 40 animals/ha, i.e. costs of € 7.70 per bird
- Group C: 150 animals/ha, i.e. costs of € 2.00 per bird.

Apart from browsing, feed consumption in group A amounted to an average of 0.311 kg of chick mixture per day in 61 days (total: 19 kg), 0.825 kg of grower mix per day in 212 days (total: 175 kg) and 0.825 kg of finisher mix in 91 days (total: 75 kg), further 2 kg of hay per day between October and the end of March (=364 kg).

Feed consumption in group B amounted to an average of 0.311 kg chick feed per day in 61 days (total: 19 kg), 2.8 kg of grower mix and 1 kg silage in 91 days (total: 593.6 kg plus 212 kg) and 2.8 kg of finisher mix and 1kg silage in 91 days (total: 254.8 kg plus 91 kg).

Feed consumption in group C amounted to a daily average of 0.311 kg of chick starter in 61 days (total: 19 kg) as well as to a daily average of pelleted prefabricated feed of 2.6 kg in 303 days (total: 787.8 kg) plus 1 kg of hay =303 kg).

Group B had very limited possibility to browse, and group C practically none, since the high density of animals left no chance for any vegetation growth.

- The price of chick starter was € 0.41 per kg.
- The price of group A's grower mix was € 0.25 per kg, finisher mix € 0.24.
- The price of group B's grower mix was € 0.22 per kg, finisher mix € 0.21.
- The price of group C's pellets was € 0.40 per kg.
- The cost of hay was € 25 per bale of 500 kg, which amounts to € 0.05 per kg.
- The cost of silage was € 15.00 per bale of 500 kg, which amounts to € 0.03 per kg.

Slaughtering/ Classification of muscles

All birds were slaughtered at the age of +/- 364 days.

All prime cuts were evaluated, following the standard muscle classification as depicted in the International Meat Buyer's

Guide Catalogue, Second Edition (published by Animal Technologies CC, Elsenburg 7607, South Africa):

Fillet: Fan Fillet (OS 1046), Eye Fillet (OS 1050), Tournedos (OS 1059), Oyster Fillet (OS 1045), Long Fillet (OS 1060F), Tenderloin (OS 1047)

Steak: Rumpsteak (OS 1035), Triangle Steak (OS 1036), Small Steak (OS 1037), Tender Steak (OS 1038), Moon Steak (OS 1041), Minute Steak (OS 1042), Long Steak (OS 1060S), Small Drum (OS 1014).

Drum: Drum Steak (OS 1011), Flat Drum (OS 1012), Big Drum (OS 1013).

Meat Quality

Altogether 186 persons engaged in five different meat tastings to look for possible differences between the different farming and feeding systems.

The following criteria were evaluated:

- Smell of the fresh meat
- Palpable characteristics of the fresh meat
- Visible fat deposits
- Smell of the cooked meat
- Taste of the cooked meat
- Tenderness of the cooked meat

A scale from one to six was used for evaluation, one being the best and six being the worst score.

Customer preferences

Altogether 812 persons were questioned concerning their rating of the importance of farming and feeding systems respecting animal welfare. Another goal was to determine their willingness to pay a higher price for meat which had definitely been produced ecologically and with respect for animals. The questioned persons were customers and visitors of the farms where groups A, B and C were raised.

Criteria of the questionnaire:

- Type of farming - extensive/intensive
- Origin of the meat – traceable (regional producer)/anonymous (wholesaler/importer)
- Quality of the meat - regional producer/anonymous producer
- Product safety - regional producer/anonymous producer
- Higher price for special quality

A scale from one to six was used for evaluation, one being the best and six the worst score.

Results and discussion

The tables 2 - 5 clearly show that birds of group A, browsers supplemented with a limited amount of the above described farm ration, were not only raised at the lowest cost but also provided the highest meat yield. Feed costs of group C, raised intensively and using commercial mixtures, were almost three times as high as in group A, and the amount of abdominal fat was by far the highest of all groups – due on the one hand to lack of exercise, but presumably also because of high energy levels in the commercial feed.

Group B, where the farmer altered the ration arbitrarily several times, provided the poorest meat yield. While these birds had almost no abdominal fat, the weight of the gizzard was the highest of all groups. The farmer had partly fed coarse silage which increased the activity of the gizzard and consequently its size.

The profit/loss account (end of table) shows the direct relation between feed costs and economic success. All remaining production costs (investments, labor and slaughter, but without entrepreneurial wages) come to a steady average of € 250.00 per bird in Central Europe and Poland. Including feed, the total cost of production per bird in the study was € 367.24 in group A, € 462.07 in group B and € 591.84 in group C.

In long-term comparison, a farmer in these countries achieves an average of about € 6.00 per kilogram of life weight when selling cuts of slaughtered ostriches. Birds of group A at an average life weight of 108,4 kg achieved of € 650.40, goup B at 83.6 kg achieved € 501.60 and group C at 92.2 kg achieved € 591.84.

The profit/loss account reveals a surplus of € 283.16 per bird of group A. The results in group B are also cost-covering, but a modest € 39.53 per bird can hardly ensure the survival of the farmer, unless he raises extremely large numbers of birds – which is unrealistic under Central European circumstances. Group C produced a deficit of € 38.64.

Gizzard and Abdominal fat showed significant differences (Table 4). Birds of group B were fed a very coarse, hard silage during fall and winter, which stimulates the gizzard activity. It is assumed that the low live weight and meat yield was caused by the low level of metabolisable energy of the diet and the high energy requirement for the activity of the gizzard. The thick layer of abdominal fat in group C is a result of lack of exercise because of small paddock size combined with consumption of high-energy pelleted feed.

Table 5 shows that meat from the extensive system (Group A) showed the best scores throughout the criteria. Group B and C had generally higher scores than group A, with the exception in fat content. In this trait group B showed the same value as group A (1.2), but the score of group C was extremely poor (5.0). The high fat content of group C especially in Fan Fillet and Triangle Steak (Figure 2 impaired the acceptance by the consumers.

Table 2. Cost for feed and pasture (€ per bird and day)

	Group A	Group B	Group C
chick starter	0.13	0.13	013
starter/ finisher mix	0.21/ 0,20	0.66/ 0,59	0.00
commercial mixture	0.00	0.00	1.04
hay	0.10	0.00	0.15
silage	0.00	0.09	0.00
pasture/ paddock	0.03	0.02	0.01

Table 3. Total cost/ bird – profit/ loss (€)

	Group A	Group B	Group C
total chick starter (61 days)	7.93	7.93	7.93
total starter (212 days)	44.52	139.92	0.00
total finisher (91 days)	18.20	30.58	0.00
total commercial mixture (303 days)	0.00	0.00	315.12
total pasture	10.19	7.28	3.64
total hay	36.40	0.00	15.15
total silage	0.00	26.36	0.00
total for 364 days/ bird	117.24	212.07	341.84
total cost/ bird	367.24	462.07	591.84
revenue/ bird (€ 6,00/ kg lifeweight)	650.40	501.60	553.20
profit/ loss/ bird	283.16	39.53	-38.64

Table 4. Selected characteristics of the slaughtered birds

	Group A	Group B	Group C
average live weight	108.4 kg	83.6 kg	96.2 kg
average meat yield*	29.00 kg	19.85 kg	23.79 kg
Gizzard**	1.1 kg	2.4 kg	1.0 kg
external/ abdominal fat	3.2 kg	1.4 kg	7.8 kg

* only fillet, steak and drum cuts, ** pure muscle - cleaned and ready for cooking

Table 5. Meat Quality (rated by a panel of 18 people from score 1 to 6; 1 = very good, 6 = very poor)

	Group A	Group B	Group C
smell (raw)	1,7	2,8	2,7
palpation (raw)	2,1	3,5	3,5
content of fat	1,2	1,2	5,0
smell (cooked)	1,3	2,3	2,2
taste (cooked)	**1,4**	**3,8**	**3,9**
tenderness (cooked)	**1,2**	**3,3**	**3,1**

A)

B)

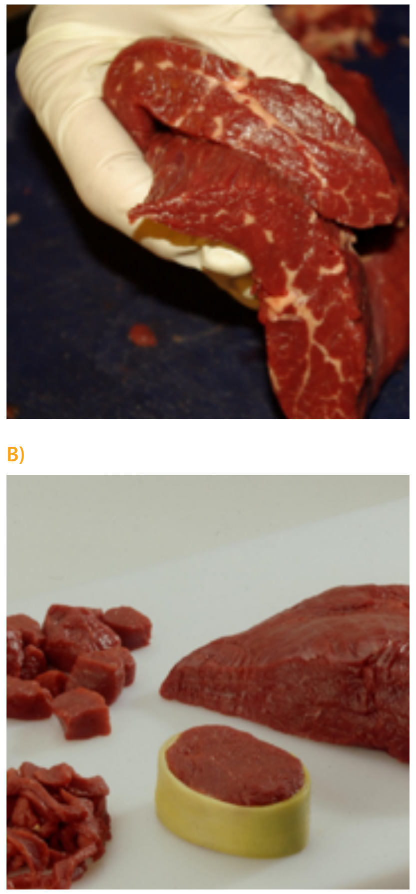

Figure 2. Intensive farming with limited space to move and highly concentrated feed results in clearly visible layers of intramuscular fat (A), while physical exercise and forage as main feed resource in the extensive system produce very lean meat (B) which is preferred by consumers.

Customer Preference

763 persons were interviewed concerning their acceptance of ostrich meat from extensive or intensive farming, from known (regional) or unknown (international) origin, and concerning their willingness to pay more for meat from known rather than unknown production. 92.2 percent of respondents preferred meat from extensive farming and 78.6 percent from known sources. 83.5 percent were willing to pay a higher price for meat from extensive farming because they believe that this product is of higher quality and produced without additives, and thus safer for the consumer.

The present study must be understood as a first step to come closer to the ideal way to farm and feed ostriches. Data from only few farms and three systems were evaluated, and obviously more investigation is needed to come to clear results for other parts of the world and for other feeding systems.

It would further be important to find out if, and to what degree, an improved system of feeding could enable farmers to slaughter ostriches at an earlier age with a higher meat yield - yet without losing meat quality (consistency of muscle, higher proportion of intramuscular fat), as is the case with most other animal production. This, however, needs more knowledge about the true nutrient requirements of the ostrich – so far feed formulas are merely based on farmers' practical experiences.

The ostrich branch must find an answer to its basic question: Can an industrial system of farming, which pushes birds to their genetic limits of growth, be a prime goal of the branch? Or should not, on the contrary, the inherent advantages of the ostrich - healthy, lean meat, hypoallergenic character of its products... - be supported by natural farming and feeding systems?

Until now the annual world production of ostrich meat (prime cuts = fillet, steak, drum) has never exceeded 7000 tons. Even if increased by 200% to approximately 20,000 tons, ostrich meat would still amount to no more than 0.008% of the world's total meat production (without fish). This taken into consideration, the branch must decide urgently which goal to head for: an industrialization of production or rather the cultivation and promotion of the very special and „green" niche product ostrich.

Conclusion

In spite of the many open questions, this study demonstrates that an extensive farming and feeding system based on the biological characteristics of the ostrich reaches the best results at the lowest expenditures. The „ecological" way of farming is the ideal road to economic success for ostrich farms operating in moderate climate zones with lush vegetation.

Further, the quality of the meat is judged to be superior if produced under extensive rather than intensive management and feeding conditions.

The customers would rather buy meat from extensive production systems and are even willing to pay a higher price for it because they are convinced of the better quality and improved product safety. Industrial, intensive farming and the use of industrially-produced feed - as is prevalent today even in countries with moderate climate and good pastures - is not accepted by the customers and endangers the survival of the farms because of high production costs and low margins.
This is not only the problem of hot and arid regions but also of countries and farms applying the intensive system for lack of space or because of an obsolete view of livestock farming.

The strict and pioneering new standards issued by the German Department of Agriculture practically force German ostrich farmers to come to an economic way of ostrich keeping which at the same time ensures the welfare of the birds. As an additional beneficial effect for producers as well as for animals the consumer has a positive image of German ostrich farming and appreciates the products farmers can offer with self-respect.

NOTES

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Current legal framework for autogenous veterinary vaccines in the EU and short-term and mid-term changes

Abstract

Strengthening the prudent use of antimicrobials by European veterinarians has resulted in an increasing interest in the use of autogenous vaccines. However until December 2018 autogenous vaccines were regulated on national level in the European member states resulting in different standards in the manufacture and quality control of autogenous vaccines. At the same time it is well known that vaccinated food-producing animals easily cross borders within Europe. Therefore not only for consumer protection reasons there is strong interest to regulate autogenous vaccines on a European level. In order to do so a new regulation on veterinary medicinal products was proposed by the European Commission and the Council of Europe in order to repeal the current Directive 2001/28/EC that excludes autogenous vaccines.

Keywords

Directive 2001/28/EC, veterinary medicinal products, autogenous vaccines, new regulation of the European Parliament and of the Council Regulation (EU) 2019/6 on veterinary medicinal products.

Introduction

On 25/26th September 2017 a joint workshop titled "Autogenous Vaccines and Their Role in Animal Health Strategies", organized by the International Alliance for Biological Standardization and the University of Gent, discussed the legal situation of autogenous vaccines in Europe in comparison to registered veterinary medicinal products. Representatives of the animal health industry and national authorities as well as the European Commission desired changes to the current legislation for veterinary medicinal products, based on experience with respect to the functioning of the veterinary medicines market, administrative burdens for registered products, scientific progress and protection of animal and public health.

In contrast to registered vaccines, autogenous vaccines are always inactivated and only allowed to be used locally, on one holding under exceptional circumstances, when a registered vaccine against an indication in a target animal is not available. The market for autogenous vaccines therefore is rather small, but their fast availability allows the veterinarian to quickly respond to new diseases or to diseases, against which no registered product is available. Batches of autogenous vaccines are rather small as they are herd and customer specific products.

Legal Situation of AV in Europe

Commission Directive 2001/82/EC as amended regulates the manufacture, control, placing on the market, import, export, supply, use and pharmacovigilance of veterinary immunologicals. It guarantees the quality of veterinary medicinal products manufactured within the Community by requiring compliance with good manufacturing practice. Each veterinary medicinal product must be authorized before being placed on the market.

Autogenous vaccines (AV) are also defined in this Directive [1)], but are excluded from its scope. The consequence of this exclusion is that AVs are not regulated on a European level. Their quality, manufacture and use depend on the individual national legislation of each member state. Legislation for autogenous vaccines differs from member state to member state.

In Germany the Animal Vaccines Act of 2006 (TierImpfVO 2006) requires that manufacturers of AV have a manufacturing authorization, issued only after inspection by the local authorities responsible for GMP. All batches manufactured must be notified to the authority responsible for GMP and includes the identity of the prescribing veterinarian, the operation of destination, target species and quantity supplied. In addition the German federal states have published a so-called "Question and Answer Paper" which includes recommendations for manufacturers and users of veterinary autogenous vaccines. However, the recommendations are not legally binding. A vaccine registration procedure including dossier evaluation for AV is currently not required in Germany. Some EU-member states hardly have any equivalent regulations. Most extensively regulated are autogenous vaccines in the United Kingdom.

Legal Situation in the UK

AVs are regulated in the Veterinary Medicines Regulation 2013 as amended. Manufacturers and their product intended to be placed on the market must be authorized by providing to the Veterinary Medicines Directorate (VMD) an application dossier that includes detailed quality documentation. Further manufacturers must either provide a GMP-certificate or ask the VMD for an inspection of the production and quality control facilities as part of the approval procedure. The need and use of autogenous vaccines in preference to UK authorized products must be soundly justified by a UK veterinarian.

Although mainly bacterial autogenous vaccines are used, also viral vaccines can be licensed. As the first manufacturer Vaxxinova GmbH in Cuxhaven received the license for the manufacture and use of autogenous Fowl-Adenovirus vaccine in the UK in 2015. Testing of viral isolates for extraneous agents as specified in the European Pharmacopoeia using validated methods is self-explanatory.

The mentioned UK-regulations on one hand seem to be a significant administrative burden to AV-manufacturers and veterinarians aiming to use AV in emergency situations. The consideration of the nature of the animal production industry on the other hand allows vaccine applications within larger epidemiological units and the use of the same isolate to produce further batches of vaccine on a quality risk basis. Each batch of vaccine must be tested for safety on-site on a small number of animals, before release of product. Adverse Reactions are notified to the Secretary of State within 15 days of learning the reaction. An overview of the requirements within some EU-countries is summarized in table 1.

[1)] AV-Definition according to Commission Directive 2001/82/EC: inactivated immunological veterinary medicinal products which are manufactured from pathogens and antigens obtained from an animal or animals from a holding and used for the treatment of that animal or the animals of that holding in the same locality.

Table 1. Current legal requirements for autogenous vaccines in some EU countries (19.12.2018)

Legal Situation Comparison State / Customer	United Kingdom	The Netherlands	Sweden	Hungary
License for placing product on the market by authorities	STC, AVA-Registration, per type of MO	No	Authorization per customer and per type of Microorganism	Authorization per type of Microorganism
CoA / batch release notification to authorities	Yes, (EU-Batch protocol)	No	Yes	Yes
Response to Batch release	Confirmation of receipt of company's batch release	No	No	Yes, batch release by competent authority
GMP-inspection	GMP or VMD inspection	Accepting German inspection	Accepting German inspection	Accepting German inspection

MO = Microorganism, GMP = Good Manufacturing Practice, VMD = Veterinary Medicines Directorate

Steps towards Harmonization in Europe

The "Recommendations for the manufacture, control and use of inactivated autogenous veterinary vaccines within the EEA" issued by the veterinary Coordination Group for Mutual recognition and Decentralised Procedures (20th March 2017) were a first step on European level to harmonize standards for autogenous vaccines. However these are currently not legally binding unless member states individually have included principles like these in their national law (e.g. the UK, Denmark, Hungary).

In a second step the conclusions of the Gent workshop were directly forwarded to the European Commission and included in a compromise "Proposal for a Regulation on veterinary medicinal products" by the European Parliament and the Council of the European Union on 5 June 2018. The new Regulation came into force in Jan 2019..

Conclusion of the Workshop and the new REGULATION 2019/6 on veterinary medical products OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL Regulation (EU) 2019/6 on veterinary medicinal products repealing Directive 2001/82/EC

1. The joint workshop in Gent agreed that AVs are useful and necessary.

2. AVs should be defined as: inactivated immunological veterinary medicinal products which are manufactured from pathogens and antigens obtained from an animal or animals in an epidemiological unit and used for the treatment of that animal or those animals in the same epidemiological unit or for the treatment of an animal or animals in a unit having a confirmed epidemiological link. *(Chapter I Subject matter, scope and definitions, Article 2 Scope (3)).*

3. The quality of autogenous vaccines should be harmonized. Although autogenous vaccines should be manufactured in accordance with the principles of good manufacturing practice, detailed guidelines of good manufacturing practice should specifically be prepared for those products since they are manufactured in a way that is different from industrially prepared products. That would preserve their quality without hindering their manufacturing and availability.

4. These special GMP-guidelines for autogenous vaccines however still need to be prepared: The obligations regarding certificates of good manufacturing practice for AVs shall only start to apply from the date of application of the implementing acts laying down specific measures on good manufacturing practice for those products. *(Chapter XII Transitional and final provisions, Article 159 Transitional provisions regarding certain certificates of good manufacturing practice)*

5. AVs shall only be used in the animals referred to therein in exceptional circumstances, in accordance with a veterinary prescription, and if no immunological veterinary medicinal product is authorised for the target animal species and the indication. *(Chapter VII Supply and use, SECTION 3 USE, Article 106 Use of medicinal products (5))*.

6. The advertising of autogenous vaccines shall be prohibited.*(Chapter VII Supply and use, SECTION 4 ADVERTISING, Article 120 Advertising of veterinary medicinal products subject to veterinary prescription (3).*

7. Also for autogenous vaccines Member States shall ensure that appropriate systems are in place for the collection and disposal of waste of veterinary medicinal products.(Article 117 Collection and disposal of waste of veterinary medicinal products)

8. Animal keepers and owners of food-producing animals must keep record of the use of autogenous vaccines (Article 108 Record-keeping by owners and keepers of food-producing animals)

9. Competent authorities shall carry out controls of manufacturers, distributors, marketing authorisation holders, wholesale distributers, retailers, owners and keepers of food-producing animals, veterinarians, registration holders and any other persons having obligations under this Regulation. (Chapter VIII Inspections and controls, Article 123 Controls)

The new regulation facilitates the use of registered vaccines.

1. Licensing of vaccines shall be facilitated e.g. by ensuring mutual recognition of national authorizations by use of special procedures.

2. Administrative burdens shall be reduced by full in-depth assessment of an application only once.

3. Veterinarians should be allowed by way of exception to prescribe other medicinal products, if authorized medicinal products are not available.

4. For limited markets and under exceptional circumstances it should be possible to grant marketing authorizations without a complete application dossier, based on a benefit-risk assessment of the situation, e.g. for minor species or for diseases that occur infrequently or in limited geographical areas. The validity of these authorizations shall be 5 years for limited markets and 1 year for exceptional circumstances.

Summary and Conclusions

The new regulation 2019/6 by European Commission and Council of Europe repeals Commission Directive 2001/82/EC and will result in harmonized standards of manufacture and quality control of autogenous vaccines within Europe, which are still to be defined however. Autogenous vaccines are manufactured in a way that is different from industrially prepared products. It is emphasized that the new standard will preserve their quality without hindering their manufacturing and availability.

Another important outcome of the new regulation is, that also for new veterinary medicinal products under GMP the way to market via registration will be facilitated.

Altogether this should result in a better availability of vaccines to veterinarians in Europe.

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GOTOMEDIA WERBE- UND MEDIENAGENTUR

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