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Study of the Drying Process in the Preparation of Granulated Feeds

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Abstract

At the present stage of development of the national economy of the Russian Federation, poultry farming is a dynamically and successfully developing branch of agricultural production. At the same time, the issue of effective and efficient feeding in the poultry industry has always been very serious. Numerous studies have revealed that the most rational is the feeding of poultry with complete granulated feed. At the same time, an analysis of the conducted studies showed that the production of feed does not fully utilize the potential of such a high-protein culture as soy, especially in combination with the waste from the processing of agricultural poultry, which constitute more than 30% of the initial weight of the carcass. Prepared in such a combination of food are quite nutritious and valuable, as they are rich in high-grade protein and are able to meet the daily need of birds in amino acids.

Based on the analytical review, by finding rational methods it was found that it is possible to increase the efficiency of poultry production through the use of modern technologies and improved technical means. It is noted that technological lines for the preparation of feed granules based on binary compositions should develop along the way of obtaining granules with low crushability and their subsequent drying, while the efficiency of the drying process of granules is largely determined by the optimal temperature distribution inside the dried granules.

Based on the foregoing, it can be concluded that the studies aimed at improving the efficiency of the granules cooking line are relevant and have important national economic significance. In the proposed work, a technological line for the preparation of granulated feeds for poultry based on soy-meat and bone compositions is proposed, and the results of experimental studies of the drying of the obtained product are given.

Keywords: poultry, binary feed, processing line, granulate, crushability, drying

INTRODUCTION

In industry, as a rule, technological lines for the production of granulated feed mixtures consist of the following main units: a hopper — a storage unit for the original components, a metering unit, a grinder, a mixer, a device for averaging moisture, a device for pressing and drying finished products, as well as additional and auxiliary equipment.

The most important operations of the cooking process are the mixing of components and pressing in the channels of the matrix of the mixture obtained. The quality of the obtained granules is determined by their density and crushability, which depend on the particle size or fractional composition, temperature, pressure during pressing, moisture content of the material and drying modes [4, 5, 13, 14]. Studies of many authors [2, 19, 22] also found that both the mixing process [2, 11, 20,], and the process of obtaining granules [2, 6, 21] are greatly influenced by the drying process [8, 9, 10 , 16, 18].

Intensification of drying and grinding of raw materials in feed production in details considered in works of P. V. Akulich, A. S. Ginsburg, K. A. Ivanov, V. Y. Karpin, V. A. Lysenko, Y. T. Tikhonova and other scientists [1, 8, 11, 12, 15, 19]. The work offers different methods of design and calculation of installations for drying of various structures: tunnel, coal mine, vibrating, pneumatic and other systems [8, 9, 16].

The above allows us to conclude that the justification of the parameters of the drying process in a production line designed to obtain granules from a wet (W = 35.0-37%) mixture of components of paste consistency, having a number of individual specific properties and indicators is an important task and can serve justification of scientific research.

2. MATERIAL AND METHODS

Production experiments have established that it is possible to reduce the amount of energy consumption when performing work on obtaining granulated fodder based on soy-meat and bone compositions by using the proposed production line [6, 7].

Analysis of the literature [4, 22, 23, 24, 25, 26, 27, 29] shows that soy is a highly effective feed product used as a protein supplement in diets of farm animals and poultry. Soy is rich in protein, important amino acids for the body, vitamins and energy, providing high productivity and quality indicators of animals and birds [3].

Based on the analysis and classification of technological operations and technical means of preparing feed additives for poultry, a promising block diagram of the technological line for the production of granulate was developed (Fig. 1).

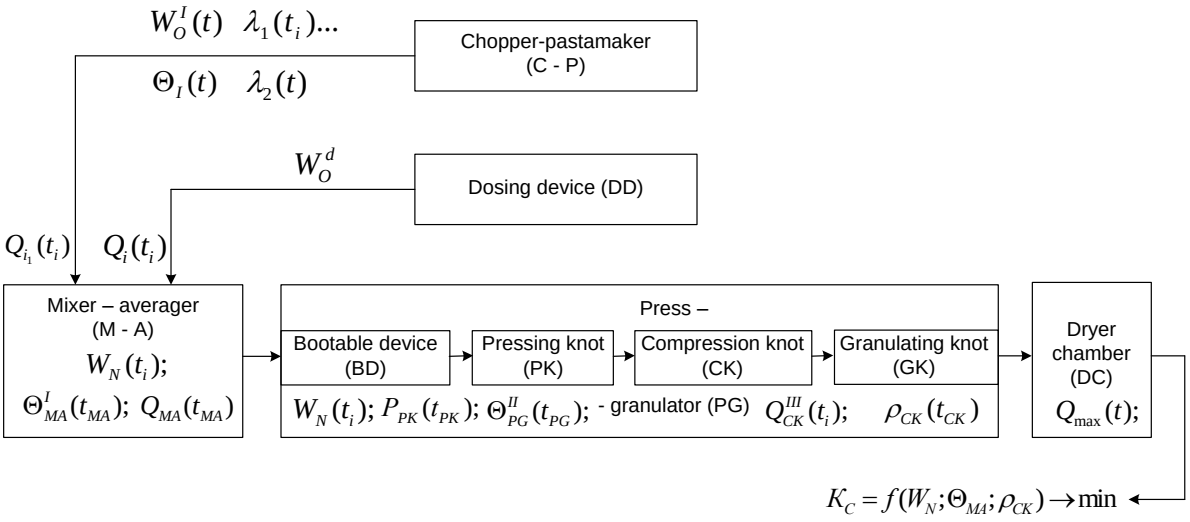

Fig. 1: An approximate structural-functional scheme of the cooking system granulated feed

In the above scheme, the following notation:

W_i (t_i) – moisture content of raw materials and components in the *i* period of time; $Q(t_i)$ – performance *i* of the system element (line) $Q(t_i)$ - performance *i* of the system element (line); $\Theta(t_i)$ – homogeneity of the mixture (by humidity) by *i* elements of the system.

The problem of increase of efficiency of technological lines and means of receiving feed products for farm animals and poultry, from the perspective of the classical approaches to the solution of the mentioned research directions, is to minimize material and labor costs, while establishing of certain restrictions on the criteria of quality of performance of the relevant operations [2].

Given this fact, for the process of obtaining high-quality feed additives in the form of granular compositions it is necessary to ensure that the following conditions are met:

– to identify ways to reduce material and labor costs in the form of reduced costs (RC_i) and damages (D_i), determine methods of the solution and solve the so-called minimization problem;

– to determine the criteria for assessing the quality of implementation of the processes under study, to reveal the factors affecting these criteria, and also reveal their dependence on the established and existing values.

During the theoretical and experimental studies, the technological scheme was developed for successful production of granules based on various components with the addition of soybean (Figure 2).

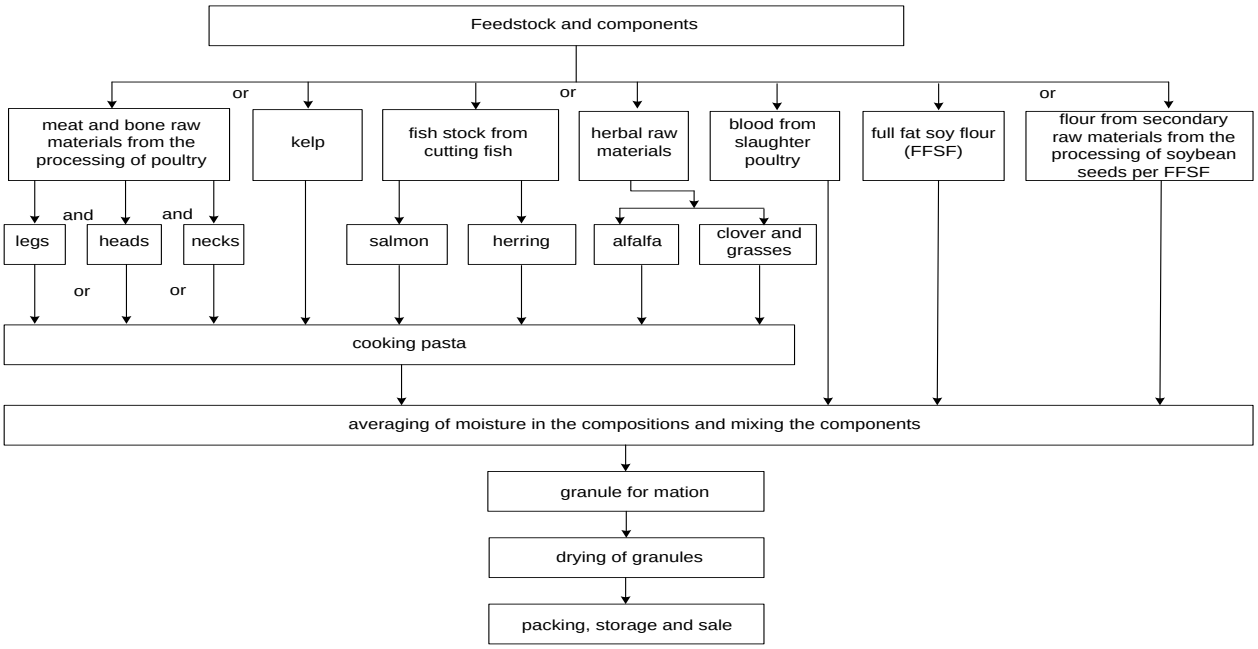

Fig. 2: The basic technological scheme of production of feed additives for poultry

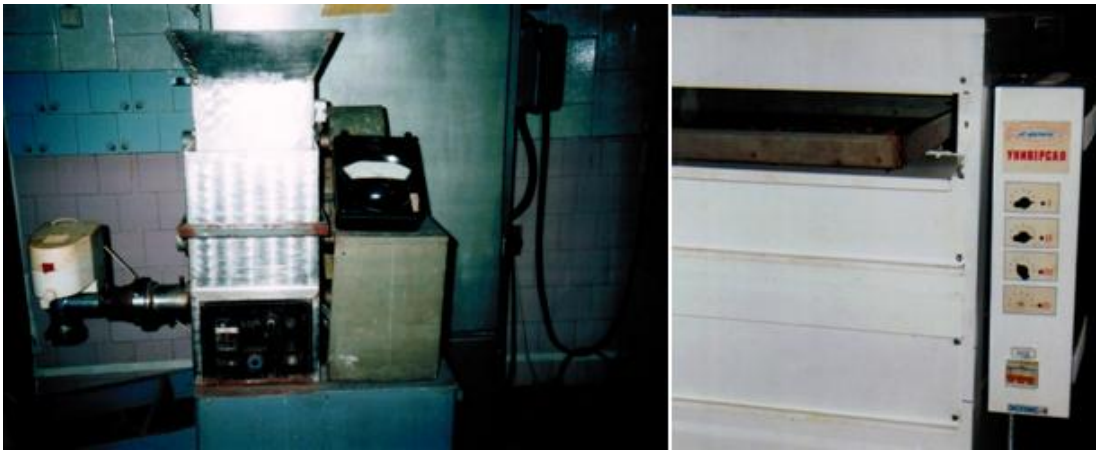

Fig. 3: General view of the press-granulator and drying rack

In the scheme of the proposed process line, an author-developed pellet mill and drying equipment is used (Figure 3). A patent of the Russian Federation for an invention was obtained for this production line [17].

3. RESULTS

Theoretical and experimental studies on the use of the proposed devices were carried out on the basis of the Far Eastern State Agrarian University, Amur Region, the city of Blagoveshchensk, the Russian Federation, as well as in real production conditions of small farms and economic entities.

To conduct production research, experimental equipment was manufactured and introduced into the production line for the preparation of soybean and meat and bone granules. The equipment was assembled in a certain sequence according to the proposed technological scheme.

In the course of experimental studies, technological equipment was used, in which it was possible to vary the factors under study in the necessary limits. In the studies used the original components: soybean and meat and bone raw materials.

When conducting studies to determine the influence of parameters of drying of wet granules (the original moisture content of the granules (W_{MG}, %), drying temperature (t_d^o, °C), the mass fraction of component soybean(M_f, %)) on the crushability of the granules (K_c) of the final product, the following results are presented, shown in Figure 4. Drying was carried out in a chute dryer of the chamber type ESPIS - 4 "Universal".

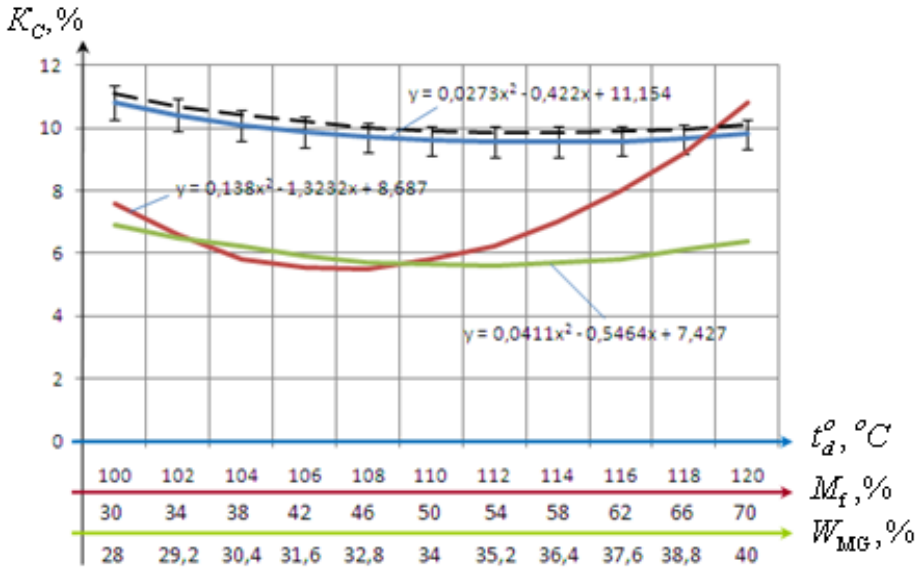

Fig. 4: The dependence of the crushability of the dried granules on the parameters of the drying process

the dependence $K_C = f(W_{MG})$ при $M_f = 51{,}4\%$;

the dependence $K_C = f(M_f)$ при $t_d^o = 95{,}6^oC$;

the dependence $K_C = f(t_d^o)$ при $W_{MG} = 40{,}6\%$;

theoretical dependence.

Analysis of the processes presented in Figure 4 shows that the crushability of the dried granules depends on the following parameters of the drying process:

- when the mass fraction of full fat soy flour at 51,4% and the initial moisture of the granules (W_{MG}) from 28 to 40 %, the crushability of dried granules decreases from 7,0 to 6,2 %;
- at a drying temperature of 95,6°C and an initial mass fraction of full fat soy flour (FFSF) (M_f) from 30 to 70%, the crushability of dried granules increases from 7,8 to 11%;
- when the initial moisture content of the granules is 40,6% and the temperature increases from 100 to 120 °C, the crushability of dried granules decreased from 11 to 9,9%.

From the above we can conclude, that on size of the crushability of dried granules the temperature of the drying agent has a great influence, granule moisture and mass fraction FFSF.

The efficiency of the drying process of wet granules is also influenced by the energy capacity of the process of drying the granules. The research results are shown in graphs (Fig. 5).

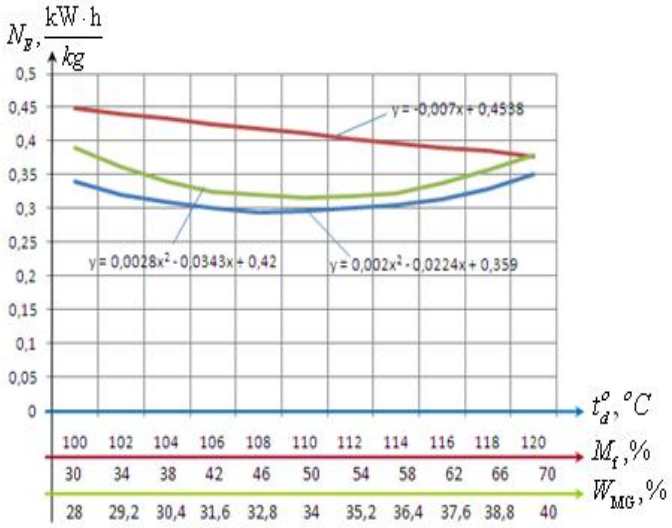

Fig. 5: The dependence of the energy intensity of the drying process of the granules on the parameters of the drying process

the dependence $K_C = f(W_{MG})$ при $M_f = 51{,}4\%$;

the dependence $K_C = f(M_f)$ при $t_d^o = 95{,}6°C$;

the dependence $K_C = f(t_d^o)$ при $W_{MG} = 40{,}6\%$;

Graphical analysis of the drying processes shows, that the smallest energy intensity is achieved when:

- a change in the initial moisture content of the granules from 30,4 to 37,6%;
- change in the mass fraction of FFSF from 62 to 70%;
- changing the temperature of the drying agent from 106 to 112 °C.

Studies have shown that the proposed tray dryer chamber type ESPIS - 4 "Universal" allows to obtain dried granules with the lowest energy consumption with optimized drying process parameters.

As a result of the research it was found that theoretical and experimental studies are within the confidence interval, which indicates the reliability of the research (Fig. 4).

4. DISCUSSION AND CONCLUSION

The results obtained by an experimental method allow us to conclude that the use of the proposed process line will allow to obtain granulated feed with a density of granules that meet zootechnical requirements.

Experimentally determined the optimal design and technological parameters for the tray dryer:

- initial moisture content of the granules 34,62 – 40,55 %;
- initial content of granules 95,64 – 110,0°C;
- mass fraction of the soy component 51,37 – 58,89% at which the crushability of the dried granules is 4.0%;
- energy intensity of the process of drying granules in the range 0,30$\frac{кВт \cdot ч}{кг}$.

It has been experimentally confirmed that the proposed technological line is highly efficient and implements original ideas and non-standard solutions.

The proposed materials of the work have been tested, implemented and successfully used in production technologies used in" Amursky Broiler"," Amuragro-Center", "AgroSEV" and a number of other leading agricultural enterprises of the Amur Region, which has reduced energy and labor costs, and also metal consumption in the technology of preparation and drying of granulated feed.

REFERENCE

[1] Akulich, P.V. Calculations of drying and heat exchange installations / P.V. Akulich. - Minsk: Belarus. Navuka, 2010. - 443 p.

[2] Aleshkin, V.R. Mechanization of animal husbandry / V.R. Aleshkin, P.M. Roshchin. - M .: Kolos, 1993. - 319 p.

[3] Babichev A.A. Soy in the USA / A.A. Babichev // Oilseeds. - 1987. - № 6.- p. 21 - 24.

[4] Bushuev, S.V. Justification of the parameters of technology and technical means for the production of protein-mineral product / S.V. Bushuev, S.M. Dotsenko, E.B. Obukhov // Vavilov Readings - 2010: International Scientific and Practical Conference - Saratov, 2010. - V. 3. - p.282 - 283.

[5] Bushuev S.V. Substantiation of the technology and parameters of the process of obtaining soy laminarine supplement for poultry / S.V. Bushuev, S.M. Dotsenko, V.V.Samuylo, S.A. Ivanov // Engineering and technical support of regional machine-building and agricultural engineering: an international scientific-practical. conf. - Blagoveshchensk, 2011. - P.208-214.

[6] Bushuev S.V. For example, it is necessary to note that this is where the laminarine supplement for poultry / S.V. Bushuev, S.M. Dotsenko, V.V.Samuylo, S.A. Ivanov // Engineering and technical support for regional engineering and technical engineering. conf. - Blagoveshchensk, 2011. - P.208-214.

[7] Voyakin S.N. Substantiation of technical parameters of the line for preparing grains with the use of soy component / S.N. Voyakin, S.M. Dotsenko, A.N. Vishnevsky // Scientific Review No. 3, 2014 P.135-138.

[8] Ginzburg, A.S. Calculation and design of food industry drying plants / A.S. Ginsburg. - M .: Agropromizdat, 1985. - 336 p.

[9] Danilov, O.L. Theory and design of dryers / O.L. Danilov. - M .: Izd-vo MEI, 1972. - 72 p.

[10] Draganov, B.Kh. Heat engineering and heat application in agriculture / B.Kh. Droganov, A.V. Kuznetsov, S.P. Rudobashta. - M .: Agropromizdat, 1990. - 464 p.

[11] Ivanov, K.A. Ways of efficient use of secondary raw materials in the meat industry: an overview. / K.A. Ivanov, S.E. Krasnov. - M .: TSNIITEI, 1970. - 21 p.

[12] Karpin, V.Yu. Improving the efficiency of the technological line of production of dry animal feed by modeling the process of the line and the working organs of the chopper of bones of farm animals: dis. Cand. tech. Of science / V.Yu. Karpin / - SPb, 2007. - 176 p.

[13] Lykov, A.V. Theory of drying / A.V. Lykov. - M.: Energy, 1968. - 471 p.

[14] Lykov, A.V. Heat and mass transfer. Directory. / A.V. Lykov. - M .: Energy, 1978. - 479 p.

[15] Lysenko, V.A. Disposal of waste from poultry processing / V.A. Lysenko // Poultry Breeding. - 2005. - №8. - p. 24 - 25.

[16] Maltri, V.M. Drying plants for agricultural purposes: Abbr. per. with him. / V.M. Maltri, E. Petke, B. Schneider: Trans. V.M. Komissarov, Yu.L. Freger: Ed. V.G. Evdokimova. - M .: Mashinostroenie, 1979. - 525 p Maltri, V.M. Drying plants for agricultural purposes: Abbr. per. with him. / V.M. Maltri, E. Petke, B. Schneider: Trans. V.M. Komissarov, Yu.L. Freger: Ed. V.G. Evdokimova. - M .: Mashinostroenie, 1979. - 525 p.

[17] Patent of the Russian Federation № 2607103 Method of preparation of protein feed product based on soy-meat compositions / Authors Dotsenko S.M., Voyakin S.N., Vishnevsky A.N., Varaksin S.V. Publ. in BI No. 1 dated 10.01.2017.

[18] Eckert, E.R. Theory of heat and mass transfer / E.R. Eckert, R.M. Drake. - M.-L.6 Gosenergo-izdat, 1961. - 520 p.

[19] Tikhonov, Yu.T. On the production efficiency of dry and meat-feeding feeds / Yu.T. T-hons // Rabbit breeding and fur farming. - 1975. - № 4. - P.17 - 18.

[20] Deep processing of collagen-rich poultry products for different use (review) Fisinin, V.I. Ismailova, D.Y. Volik, V.G. Lukashenko, V.S. Saleeva, I.P. 2017 Sel'skokhozyaistvenna-ya Biologiya, Volume 52, Issue 6, 2017, Pages 1105-1115.

[21] Attia, Y. A., El-Tahawy W. S., Abd El-Hamid A. E., Nizza A., Bovera F., Mohammed A. Al-Harthi and El-Kelway M.I. (2014). Effect of feed form, pellet diameter and enzymes supple-mentation on growth performance and nutrient digestibility of broiler during days 21-37 of age. Archiv Tierzucht 57 (2014), 57, 34, 1-11. doi: 10.7482/0003-9438-57-034

[22] Yegorov I. High-protein soybean extraction cakes in compound feeds for broiler chicks / I. Yegorov, T. Yegorova, R. Roshchupkin, S. Kudinov // magazine "Mixed feed", 2017, №7–8.

[23] Anderson-Haferman, J. C., Y. Zhang, C. M. Parsons, and T. Hymoitz. 1992. Effect of heating on the nutritional quality of kunitz-trypsin-inhibitor-free and conventional soybeans for chick-ens. Poultry Sci. 71:1700-1709.

[24] Clarke, E., and J. Wiseman. 2007. The effect of extrusion conditions on trypsin inhibitor activi-ty of full fat soybeans and subsequent effects on their nutritional value for young broilers. Br. Poultry Sci. 48: 703-712.

[25] Coca-Sinova, A. de, D. G. Valencia, E. Jiménez-Moreno, R. Lázaro,† and G. G. Mateos. 2008. Apparent ileal digestibility of energy, nitrogen, and amino acids of soybean meals of different origin in broilers. Poultry Science 87:2613–2623.

[26] Ruiz, N., E.A. Vargas, and F. de Belalcázar. 2008. Field observation: Effects of long term feed-ing of soybean meal high in trypsin inhibitors to broiler breeders. Poult. Sci. 87(Suppl. 1):30.

[27] A.M.H. Subuh , M.A. Motl , C.A. Fritts and P. W. Waldroup , 2002. Use of Various Ratios of Extruded Fullfat Soybean Meal and Dehulled Solvent Extracted Soybean Meal in Broiler Diets. International Journal of Poultry Science, 1: 9-12.

[28] Lázaro, R.; Mateos, G. G.; Latorre, M. Á.; Piquer, J. (2002) Whole soybeans in diets for poul-try (http://www.asa-europe.org/pdf/sbforpoultry.pdf**).