

New conception of energy balance control in poultry.

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For many years ration of poultry have been gradually enriched with various sources of starch (grains) and protein (oil meal, cakes) with a purpose to improve productivity (egg and meat production). This led to very serious consequences. Within the time, metabolizable energy of feed appeared to be higher than the energy that poultry really needed. This energy excess had no other way but to be partially spent/stored via forming triglycerides (lipogenesis) with their following accumulation in different tissues including liver hepatocytes (hepatosis). Due to that, different liver functions, including one very important – endogenous glucose synthesis (gluconeogenesis), were disturbed. Another, later coming consequence of fat accumulation was insulin resistance. Thus in the conditions of- overfeeding, continuous fat accumulation, improper metabolic functioning of the liver and bad glucose absorption by the tissues, poultry was falling to the negative energy balance. Such state of health was accompanied by numerous metabolic disorders, low feed conversion and early decrease in productivity. Moreover, described above conditions appeared to be harmful for intestinal microbiota of poultry. Excessive glucose derived from feed (starch) and products of glucose oxidation substantially suppressed growth of profitable intestinal microflora (phenomenon called - catabolite repression). This led to inability of intestinal microbiota to hydrolyse diet proteins and polysaccharides and support colonocytes with energy. Bad state of gut promoted decrease in poultry immunity.

After all mentioned above was finally considered as a real problem it has been found a solution of how to compensate all these problems. The point was to use feed additives to obtain better digestion and overcome negative energy balance. The most important of them were free essential amino acids: lysine, methionine and threonine, and enzymes, including phytase and group of enzymes that degrade non-starch polysaccharides (xylanases, glucanases, etc.); as well as various pre- and probiotics.

What has changed such strategy?

1. Enzymes.

Not going deep into the well-known problem of phytin oxidation, it is necessary to accept that usage of enzymes may lead to enhanced release of short-chain fatty acids during degradation of non-starch polysaccharides and following increase of energy levels (activation of citric acid cycle - TCA cycle). Another declared effect of exogenous enzymes is increased bioavailability of grains and cakes. This means improved release of amino acids from the feed and thus it is a positive factor as well. Meantime increased bioavailability of starch is an obviously negative factor, because it enhances catabolite repression of intestinal microflora and risk of metabolic disorders.

2. Free amino acids are readily available substrates and are quickly metabolized mainly on the route of glucose synthesis, raising adenosine triphosphate (ATP) levels. Free amino acids provide poultry organism with energy, remove deficiency in essential amino acids needed for protein synthesis

and, consequently, promote weight gain and productivity. However, usage of free amino acids leaves the problem with metabolic disorders unsolved. Very high level of energy created by exogenous amino acids leads to intense energy «release» (we propose to use this general term for all processes in poultry organism which could be recruited for utilization of energy obtained from the feed) through lipogenesis, this creates energy deficit and further decrease in productivity. It is also necessary to remember that concentration of amino acids in blood is feedback regulated. This means that rapid increase of amino acids blood concentration after their uptake with a feed immediately depresses release of amino acids from feed proteins via inhibition of endogenous proteolytic enzymes. In such conditions bad feed conversion is usually observed.

3. It is well known that a number of compensatory mechanisms in case of metabolic disorders are directly related to reanimation of intestinal microbiota. And if previously low immunity of poultry was compensated by using antibiotics, now, due to antibiotics prohibition, various probiotics, prebiotics, "phytonics" (essential oils of plants) and other immunity stimulators are actively used.

It is obvious that supplementation of poultry feed with such number of substances should lead to the rise of ration cost and thus to decrease of poultry business profitability.

Based on the observations made on the poultry farms and biochemical knowledge specialists of ELEST biotechnological company have proposed a hypothesis defining the ways of energy «release» in the organism of poultry. Mild lipogenesis, glycogen and creatine phosphate accumulation, bodyweight gain, normal size eggs production, feather cover development and improvement, etc. – are the ordinary processes on which energy is spent and this should be considered as a «normal release» of energy. Once excessive fat synthesis and production of extra-large eggs or some other abnormal processes (like cancerogenesis, for instance) on the background of bad feed conversion are observed this should be considered as «pathological release» of energy (see Figure 1). These mechanisms of «release» have different contribution in terms of energy utilization. It is obvious that the «pathological release» is much more powerful, emergency tool in comparison to the «normal release». «Pathological release» becomes predominating in case of energy overload in the poultry organism. This is what usually happens when the ration is overloaded with starch and is additionally enriched with free amino acids. Just after poultry has eaten such feed next metabolic sequence is getting initiated: dramatically fast rise of energy (ATP) is followed by the blockage of glycolysis and activation of «pathological release» mechanisms leading to strong energy decrease (negative balance of energy). Next, to compensate low level of energy fowl increases feed intake, however, this appears to be ineffective due to improper functioning of specific enzymes and intestinal microflora. Listed above describes paradoxical situation – Feeding with ration which is overloaded with energy leads to the permanent deficit of energy and bad feed conversion.

Summarizing, it is obvious that a new tool - a regulatory complex allowing to control energy flows (speed and intensity of ATP formation and thus «release» directions) in organism of poultry –

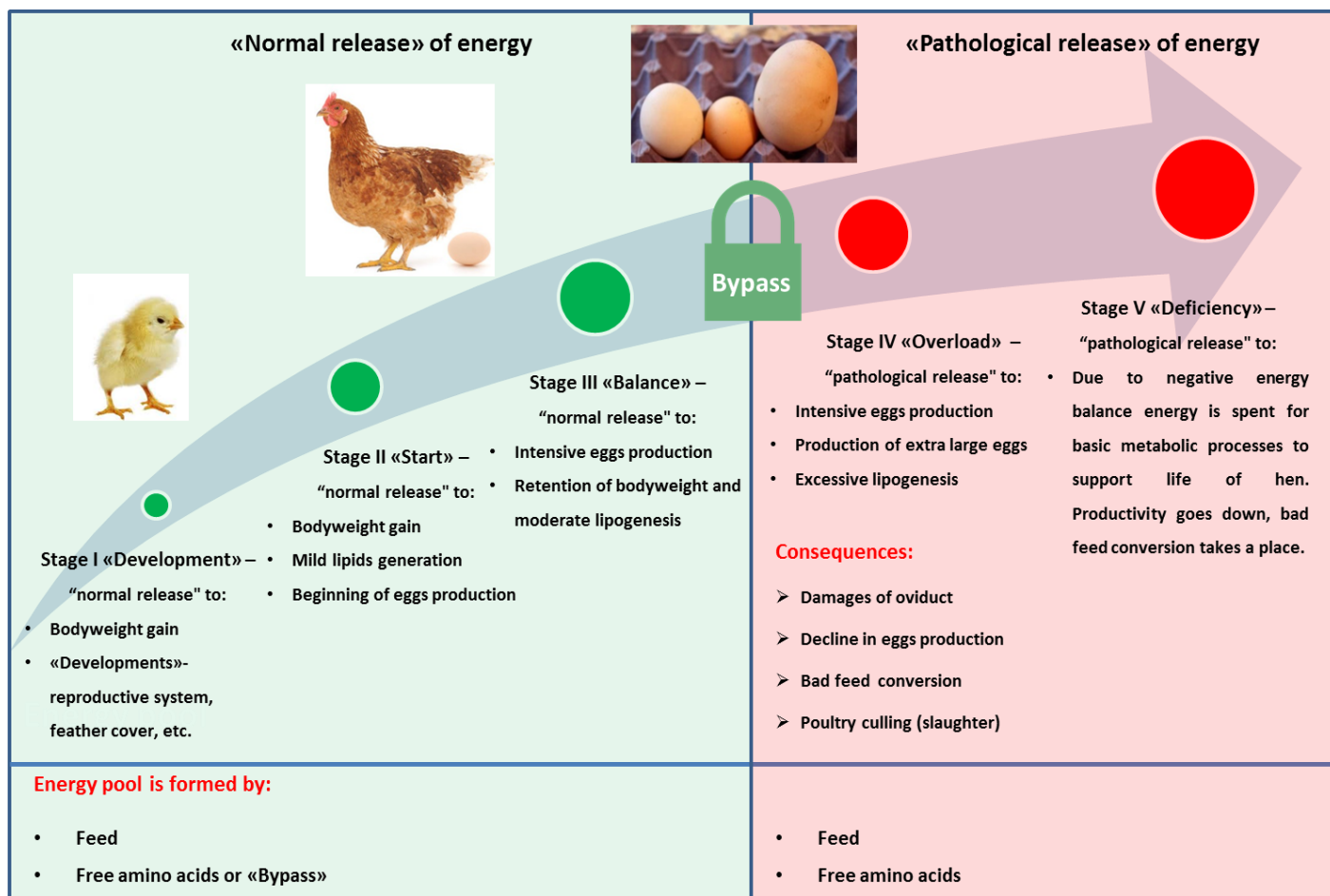


Figure 1- Directions of energy «release» in organism of poultry fed with free amino acids or «Bypass»

needs to be created. In our opinion development of such new product should be based on following conditions:

1. Regulatory complex should contain substances-metabolites of poultry organism which are naturally participating in energy metabolism. Concentrations of these ingredients should not be high but sufficient to provide optimal poultry development and productivity, meantime not initiating «pathological release» of energy in the directions of lipogenesis and other pathological processes.
2. Regulatory complex should contain antioxidant-hepatoprotective components preventing hepatitis and intensifying activity of liver.
3. Regulatory complex should contain "essential growth factors" for intestinal microflora. Well-developed beneficial biota will oxidase excess of starch in the feed. Non-starch polysaccharides will be slowly oxidized in large intestine providing poultry organism with short chain fatty acids i.e. with «smooth» additional energy.
4. Regulatory complex should contain substances-«oxygen transporters» and substances intensifying blood circulation with the aim to keep active oxidative phosphorylation and additionally protect poultry from heat stress in case of hot weather periods.

5. Once such regulatory complex will be created and applied, as a general rule - Free amino acids should be removed from the ration. Feed conversion should be used as the main natural criteria pointing on the level of energy in poultry organism. Bad feed conversion suggests that negative energy balance takes a place and the dose of regulatory complex should be raised.

Specialists of ELEST biotechnological company have created a regulatory complex called «Bypass» which stays in the agreement with all above-mentioned conditions. This product was studied in number of experiments performed on poultry farms, this allowed to make «Bypass» composition maximally balanced and efficient (Table 1). Today dozens of egg producing companies use «Bypass» and have totally excluded free amino acids and other "unnecessary" components from poultry diets.

Bypass Composition	Effects
Organic acids and some other ATP precursors	Intensification of energetic processes (glycolysis, Krebs cycle, etc.)
Amino acids (except methionine and lysine) in liposomal form	Complex effect on poultry biomass gain, microflora formation, glucose and creatine phosphate generation
Vitamins of B group	Cofactors- intensification of metabolism
Dietary fibres	Prebiotics- development of beneficial biota, SCFA formation
Hepatoprotective substances	Improvement of liver functioning
Oxygen transporters	Intensification of oxidative phosphorylation, heat stress protection

Table 1- «Bypass» composition

What «Bypass» farm trials have shown?

«Bypass» provides «smooth» energy generation and its «normal release» on normal size eggs production, adequate fat accumulation, development of feather cover, bodyweight gain, etc., avoiding active lipogenesis and other pathological processes (Figure 2 and 3). Feeding with «Bypass» was

always accompanied by good feed conversion. Figure 2 shows the dynamics of productivity, feed uptake and weight gain in the period of 86 weeks for hens fed with addition of «Bypass» or free amino

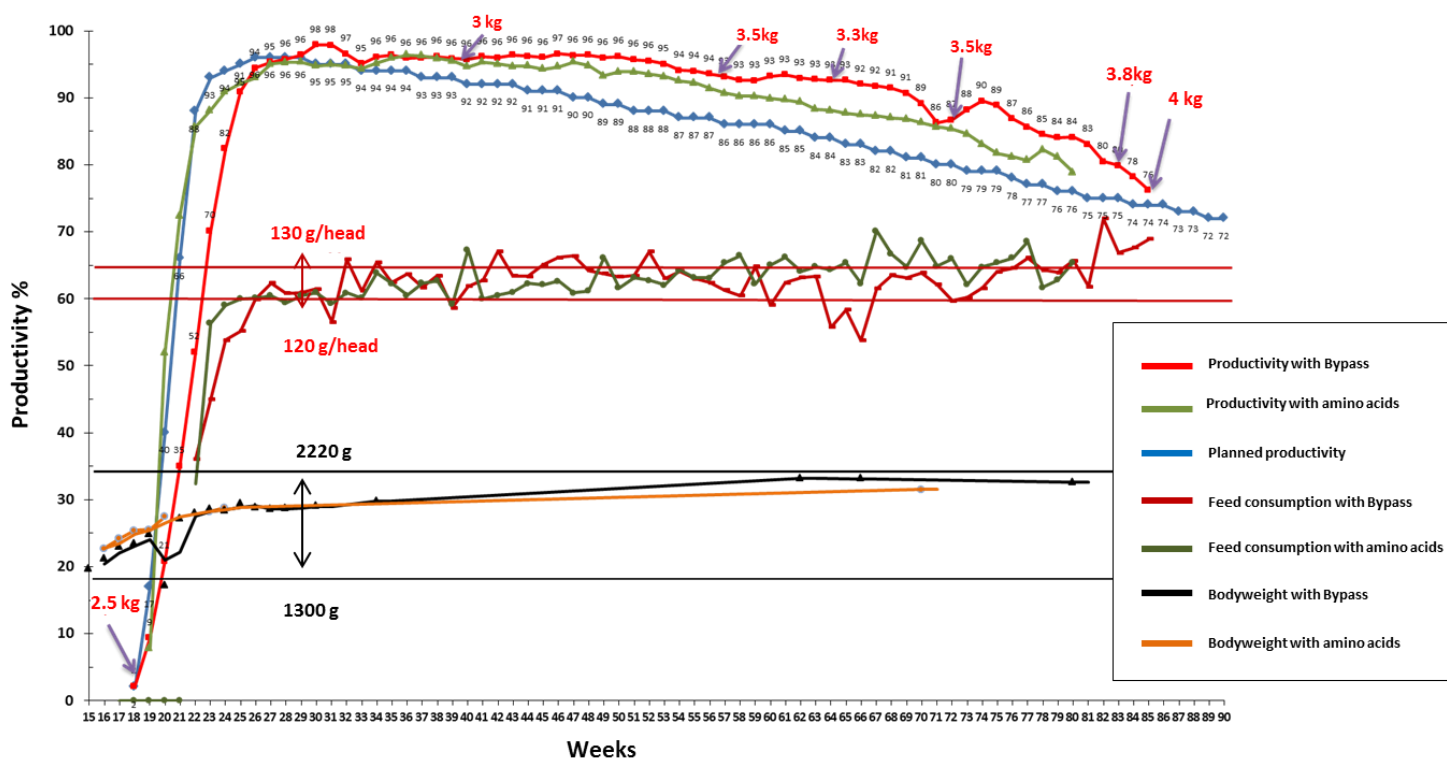


Figure 2- Productivity of poultry fed with free amino acids and «Bypass» on RUS Farming Enterprise

acids to the ration (experiment was performed on RUS’ Farming Enterprise).

The key advantages in case of «Bypass» usage (based on the results obtained on RUS’ Farming Enterprise):

- Higher productivity: 4-5% higher than in case of free amino acids usage and 10% higher than in case of standard ration without additives
- Extended productive period
- Better feed conversion
- Possibility to control eggs size (Figure 3)
- Good health of poultry (Figure 4)
- Possibility to eliminate molting
- Reduction of ration cost when compared with free amino acids usage
- Decrease of eggs production prime cost
- Increase of profit

Another interesting conclusion that could be done from Figure 2 data is that energy deficiency that appears for some reasons and leads to decrease of productivity and increase of feed uptake, what could be called in other words- bad feed conversion (weeks 57 and 72) could be compensated by raising

«Bypass» dosage (from 3 to 3,5 kg during 57- 62 and 70 - 74 weeks). Decline in productivity starting from 74-th week was probably caused by the stress and additional energy consumption by the hens due to extreme temperature fall which happened at this time (winter period) in the area where experiment was performed. We assume that this decline could be compensated by raising «Bypass» dosage up to 4 - 5 kg/ton what was not done in this case but what we will prove in further experiments.

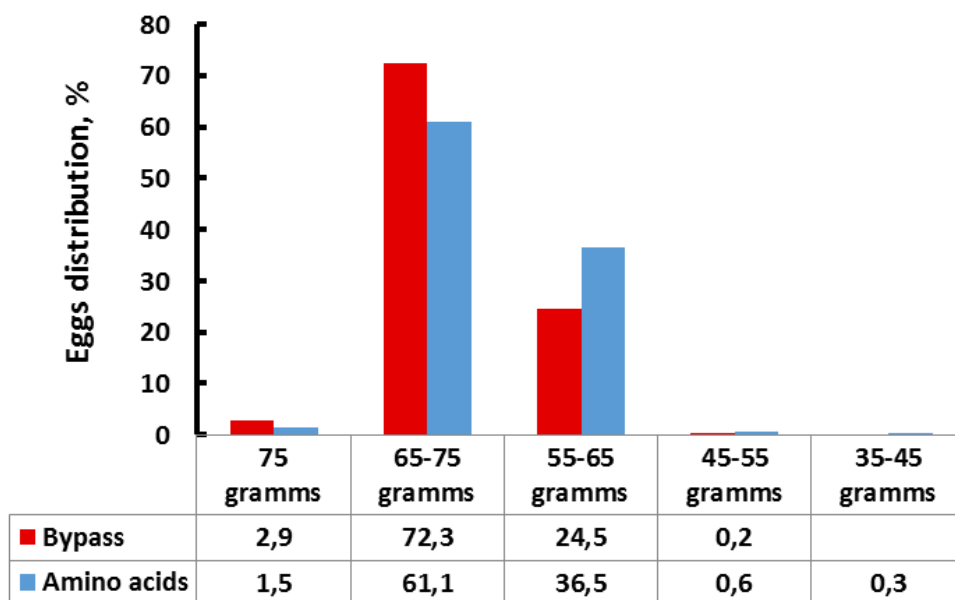


Figure 3- Distribution of eggs depending on their seize in case of «Bypass» and free amino acids use

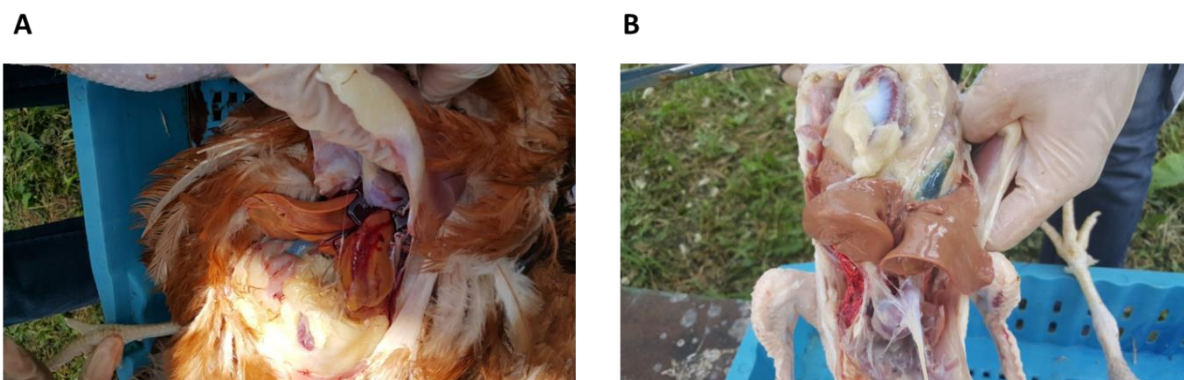


Figure 4- Liver of poultry fed with free amino acids (symptoms of hepatic lipidosis) (A) and «Bypass» (healthy liver) (B)

Conclusion

Long-term studies performed by the specialists of ELEST Company on the poultry farms are showing that depending on feeding several mechanisms of energy «release» (we propose to use this general term for all processes in poultry organism which could be recruited for utilization of energy obtained from the feed) in organism of poultry exist. Once excessive feeding takes a place, uncontrollable raise of energy induced by free amino acids and exogenous enzymes leads to «pathological release» of energy on extra-large eggs production, intensive lipogenesis, etc.. «Pathological release» is very energy consuming thus in a short time it causes negative energy balance. Excessive feeding also inhibits activity of poultry own enzymes and growth of intestinal biota, making digestion inefficient. As a result, energy deficit together with bad feed conversion are not allowing to maintain high productivity for a long time.

Our studies pointing on the possibility to feed poultry without using free exogenous amino acids (lysine, methionine and threonine) and enzymes. Such way of feeding possesses undoubtful advantages since it creates a possibility to avoid «pathological release» of energy and activate poultry own enzymes. Listed above becomes possible when the feed is supplemented with regulatory complex «Bypass». «Bypass» contains number of substances - natural metabolites of poultry organism which are activating energy producing processes like TCA cycle and oxidative phosphorylation, energy storing processes like creatine phosphate metabolism, glycogen synthesis and energy spending processes like biomass formation, productivity, feather cover formation and nutrition etc.. «Bypass» provides smooth ATP (in other words energy) production and utilization, thus it creates permanent energy oscillation allowing poultry to convert feed with maximal efficiency to the energy and not to store it in a form of fat. Due to prebiotic components «Bypass» stimulates intestinal microbiota, this intensifies feed digestion and provides poultry with additional energy source via SCFA (short-chain fatty acids). Co-factors in «Bypass» composition are positively affecting own poultry enzymes activity and hepatoprotectors are providing normal liver functioning. **Important is that if due to some unexpected stresses energy deficit occurs and bad feed conversion points on it, it could be quickly eliminated via raising «Bypass» dosage.**

To conclude, it is possible to say that «Bypass» is a «key» that opens the possibility for the farmers to have healthy hen with extended productive period on the ration that costs less.