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SUMMARY - The use of liquids in animal nutrition is increasing, as it offers many advantages. Eurolysine proposes two kinds of liquid lysine, a low concentrated monohydrochloride ELL28 and a high concentrated lysine base LLB50. This presentation aims to set out our experience concerning the more concentrated product LLB50. Zootechnical trials on broilers and pigs have shown that equivalent performances are obtained with liquid lysine base and crystalline L-Lysine HCl. A description is given, including some characteristics of the product, the analytical method to determine the lysine content and its stability and compatibility with other liquid additives. The advantages of liquid lysine are developed, some of which are illustrated with data of our experiments. Key points for the success of liquid lysine utilization conclude the presentation.

Key words: Liquid amino acids, L-lysine, homogeneity, compatibility, feedmills.

RESUME - *"Application des acides aminés liquides dans l'industrie de l'alimentation animale". L'utilisation des liquides en alimentation animale se développe de plus en plus car elle offre de multiples avantages. Eurolysine commercialise deux types de lysine liquide ELL28 et LLB50 et cet exposé a pour but de présenter notre expérience concernant le produit le plus concentré LLB50. Des essais zootechniques sur porcs et volailles ont montré l'équivalence des performances en comparaison avec le monochlorhydrate. Une description du produit donne des éléments sur les caractéristiques du produit, la méthode d'analyse, et sa stabilité et compatibilité avec d'autres additifs liquides. Les avantages de la lysine liquide sont développés et certains sont illustrés par des résultats de nos expériences. Les points importants pour réussir l'utilisation de la lysine liquide concluent cette présentation.*

Mots-clés : *Acides aminés liquides, L-lysine, homogénéité, compatibilité, usines d'aliments du bétail.*

Introduction

Liquid Lysine Base 50 is an aqueous solution containing a guaranteed minimum of 50% lysine. It contains lysine in a form identical to that in crystalline L-Lysine HCl 99% Feed Grade containing minimum 78% lysine. The active molecule is exactly the same in both products.

Liquid Lysine Base 50 is a natural form of lysine, identical to that found in feedstuffs such as cereals and soya, with the advantage of being 100% digestible.

Liquid Lysine Base 50 is produced by fermentation of natural carbohydrate sources by a specialized bacteria.

Liquid Lysine Base 50 has the same nutritional value and supports animal performance equal to crystalline L-Lysine HCl.

Equivalence of liquid and crystalline lysine determined by bioassay

Trial on broilers

A comparison of the zootechnical performances of broilers fed on two different forms of lysine supplementation, liquid lysine or crystalline L-Lysine HCl, was studied at Unicopa Research Centre in France. The trial was carried out in 2 buildings each of 24 pens (2 rooms with 12 pens). 50 male and 50 female broiler chicks (ROSS) were placed in the pens. The trial lasted 37 days. Six dietary

treatments were compared, differing either in the lysine level or in the form of pure lysine supplementation, according to Table 1. The diet is the only parameter studied, with 6 treatments and 8 repetitions. The animals received only one diet over the trial period. Basic diet 1 contained a low lysine level of 0.80% while the other nutrients and energy were above requirements, i.e., lysine was the only limiting factor. Other diets were obtained by supplementing the basic diet with Liquid Lysine Base 50 or crystalline lysine HCl 99%.

Table 1. Composition of the diets

Diet	Composition
Basic diet 1	Base lysine content 0.8% without added pure lysine
Diet 2	Basic diet + 0.1% lysine (supplemented with Lysine HCl 99%)
Diet 3	Basic diet + 0.1% lysine (supplemented with Liquid Lysine Base 50)
Diet 4	Basic diet + 0.2% lysine (supplemented with Lysine HCl 99%)
Diet 5	Basic diet + 0.2% lysine (supplemented with Liquid Lysine Base 50)
Diet 6	Basic diet + 0.3% lysine (supplemented with Liquid Lysine Base 50)

25 broilers per pen were weighed at 12 and 21 days. At 28 days and 37 days all the birds were weighed. The feed intake was measured between weighings.

The data were submitted to a variance analysis with a GLM procedure from SAS. The comparison of the average values was done by using a T test.

The increase of the dietary lysine content (in liquid or crystalline form) resulted in a significant improvement of the performances at each step. For the same level of lysine, no significant differences in bodyweight gain were observed between the 2 forms of supplementation (Liquid Lysine Base 50 or crystalline Lysine HCl 99%) as shown in Fig. 1.

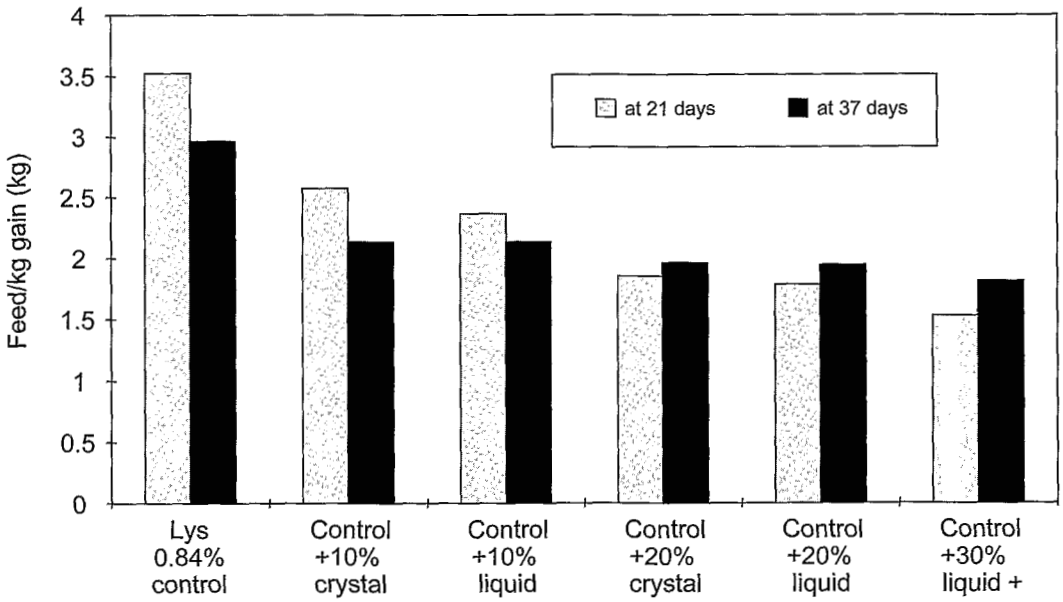

Fig. 1. Effect of lysine supplementation on feed conversion ratio of broilers at 4 dietary levels at 21 and 37 days - comparison between LLB 50 and crystalline Lysine HCl.

For Feed Intake and Feed Conversion Ratios, the 2 forms of supplementation gave identical performances as shown in Fig. 2.

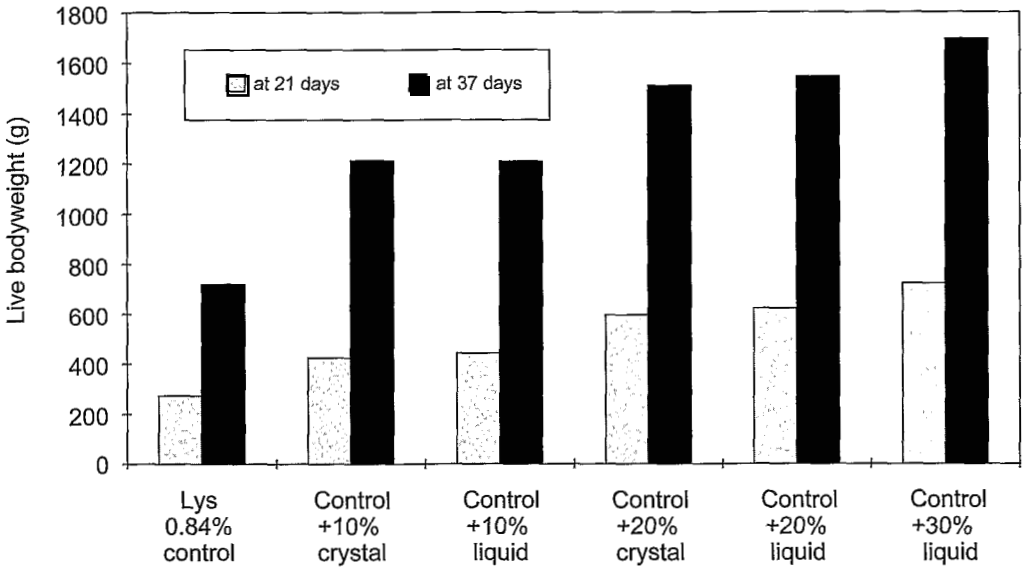

Fig. 2. Effect of lysine supplementation on growth of broilers at 4 dietary levels at 21 and 37 days- comparison between LLB 50 and crystalline Lysine.

Subsequent to the low lysine content in the basic diet (0.8%), the zootechnical performances obtained with this basic diet were low. The growth retardation between the basic diet and the diet with the higher content of lysine was about 2 weeks. The supplementation with lysine gave significantly improved performances at each step. Lysine was the limiting factor which makes possible the comparison between liquid and crystalline lysine supplementation.

For the period 0-37 days, performances were identical for liquid and crystalline lysine for the same dietary lysine level.

In conclusion, Liquid Lysine Base 50 and crystalline Lysine HCl have the same efficiency for broilers.

Trial on piglets

The trial was carried out with 2 groups of 120 piglets each. Two dietary treatments were compared differing in the form of the pure lysine added at a level of 0.25% expressed in base lysine. The trial was carried out in 2 post - weaning rooms with 10 pens containing 10 to 11 piglets. Piglets were weighed at the time of weaning, 21 days after the weaning and at the end of the post - weaning period. A daily weight gain per period and a total daily weight gain were calculated for each piglet. The feed intake was measured between weighings for each diet and each pen. The feed conversion ratio was calculated by pen.

The data were submitted to a variance analysis with a GLM procedure from SAS. The comparison of the average values was done by using a T test.

The trial went normally without mortality or sanitary troubles. No significant differences in bodyweight gain, feed intake and feed conversion ratio were observed between the 2 forms of supplementation (Liquid Lysine Base 50 or crystalline Lysine HCl 99%) as shown in Table 2.

In conclusion, Liquid Lysine Base 50 and crystalline Lysine HCL 99% have the same efficiency for pigs.

Table 2. Zootechnical results on pigs

Treatment	Diet 1	Diet 2
Form of lysine	Crystal lysine	Liquid lysine
Weaning to 21 days		
Initial weight (kg)	8.54	8.61
Final weight (kg)	15.20	15.51
Daily weight gain (g)	318	329
Feed conversion ratio (kg feed/kg gain)	1.26	1.25
21 days to end		
Final weight (kg)	23.84	24.24
Daily weight gain (g)	700	707
Feed conversion ratio (kg feed/kg gain)	1.50	1.51
Weaning to end		
Final weight (kg)	23.84	24.24
Daily weight gain (g)	459	468
Feed conversion ratio (kg feed/kg gain)	1.39	1.39

Application of Liquid Lysine Base 50 in animal feed production

Due to its physical characteristics, Liquid Lysine Base 50 is easy to handle. Liquid lysine viscosity is low, with an average 60 centipoise at 20°C as compared to a minimum of 2000 to 5000 centipoise for molasses. It can be stored at all temperatures above minus 10°C and therefore does not require any sophisticated equipment. Liquid Lysine Base 50 does not freeze at minus 18°C. Liquid Lysine Base 50 is neither aggressive, nor corrosive and thus allows the use of standard material for the installation (Table 3).

Table 3. General indications on the product

Characteristics	Indicative values
Density	1.13 - 1.18
Viscosity 20°C	60 - 80 cps
pH (20°C)	10 - 11
Boiling point	110°C - 120°C
Freezing point	< -18°C
Crystallization point	< -18°C
Conductivity	3000 microsiemens/cm

Liquid Lysine Base 50 contains a guaranteed minimum of 50% L-lysine. The product is pure and contains a low percentage of mineral substances and organic matter. It does not contain carbohydrates or fatty matters.

The analytical procedure for determining the lysine content in Liquid Lysine Base 50 is the same as for crystalline L-Lysine HCl 99% Feed Grade. The determination of the amino acid content in Liquid Lysine Base 50 is carried out by amino acid analysis. Lysine is extracted with diluted hydrochloric acid, measured through reaction with ninhydrin reagent and determined colorimetrically at 570 nm. Analyses are carried out in duplicate with a standard solution before and after the samples

for calibration. If the spread between the 2 samples is higher than 1.5%, the analyses must be completed by a third analysis.

Concerning stability during storage, the product is stable throughout a wide range of temperatures (between minus 10°C Celsius and 60°C) and does not freeze at minus 18°C. Concerning feed making aspects, stability is excellent during pelletization at 85°C. Stability during extrusion at high temperature is globally good but could be influenced by process parameters, such as steam percentage, temperature and by feed composition. For incorporation in vitamin and mineral premixes, up to 5% of Liquid lysine can be incorporated with good results.

The behaviour of Liquid lysine mixed with other liquid additives used in animal feeds was important to test. Liquid Lysine Base 50 was mixed with various other additives to test the evolution of the mixture over several months. Each time, these mixtures were prepared with three different proportions to simulate a wide range of needs in the industry. Subsequently, regular analysis and observations were carried out to follow the chemical and physical evolution of the mixtures over three months.

The results have shown that Liquid Lysine Base 50 is compatible with the main additives as indicated in Table 4.

Homogeneous mixing is obviously not possible with liquid fats or oils.

Table 4. Compatibility of liquid lysine with other liquid additives

Liquid additives	Compatibility	Comments
Methionine hydroxy analogue	Very good	
Choline chloride	Good	Ratio choline/lysine less than 1/5
Formic acid	Very good	
Propionic acid	Very good	
Citric acid	Very good	
Flavours	Very good	
Liquid fats -oils	Not recommended	Not homogeneous

Advantages of liquid amino acids in animal feed production

Easier handling

Use of liquid lysine allows rapid unloading of trucks and avoids the manual handling of pallets and bags between storage and production, and the disposal of packaging waste. The product can be directly incorporated in the feed mixer.

Easy and safe storage

Fast checking of stock level is possible with a tank-gauge. There is no risk of moisture absorption as compared with powder storage. Warehouse space could be released and raw material silos are made available for other products.

Environmental benefit

Use of liquid lysine avoids dust in feedmills and improves the cleanliness of feedmills and the working environment.

Reduction of product loss

No product spillage occurs during manual handling and no residues in bags or pipes are wasted.

Greater flexibility in feed formulation

Variable inclusion rates can be applied and accurate, fully automated dosage even at low inclusion rates can be obtained.

Assured lysine content in feeds

Use of liquid lysine improves the homogeneity of lysine distribution in feeds and reduces the risk of demixing. With liquid lysine the incorporation can be fully automated, avoiding human errors.

Improved feed quality

Pellet hardness is enhanced with liquid lysine.

The experience with incorporation of Liquid Lysine Base 50

The main questions posed by the Feed Industry are related to: (i) homogeneity in the mix; (ii) installation; and (iii)logistic constraints.

An important advantage of liquid lysine for the Feed Industry is the improvement of the homogeneity of feedmix and the possibility of using a low incorporation rate.

We tested about 50 installations by analysing about 1000 samples. While testing an installation, the analysis of added lysine was carried out on 6 to 10 samples of feeds with a low and a high incorporation of lysine. The variation coefficient was calculated for each series. Conclusions further to these tests were that measured lysine content in feeds matched the expected value. An important decrease of the variation coefficient was observed with liquid lysine (the lower the coefficient is, the better the homogeneity in the feed); it was halved - for example the variation coefficient was 3% for Liquid Lysine instead of 7% for crystalline lysine.

Table 5 shows an example of comparative results obtained in one industrial trial testing the homogeneity of the feed mix with comparison of liquid lysine, crystalline lysine and lysine on carrier. The feeds were prepared in the same mixer to avoid differences due to the apparatus. For each form of lysine, 20 samples were analysed in duplicate. Average content, standard deviation and variation coefficient were calculated. This example illustrates well the better results obtained with liquid lysine.

Homogeneity tests allow checking of other abnormalities in the mixing quality of the equipment.

Table 5. Comparison between liquid lysine, crystalline lysine and lysine on carrier

	Average content (%)	Standard deviation (%)	Variation coefficient (%)
Liquid lysine	0.160	0.0044	2.74
Crystalline lysine, HCl straight incorporation	0.157	0.0091	5.80
Lysine HCl on carrier	0.157	0.0121	7.71

The system for the incorporation of liquids could be a classic system with injection of liquids by nozzles or by microspraying. Several liquids could be incorporated with an accurate dosage. The Microspraying system appears to be particularly well adapted and easy to install. It is fixed on the mixer in 30 minutes. Its maintenance is easy, with a system which remains clean thanks to the injection of air to empty the apparatus after the incorporation of the liquid.

The product is easily transported in standard trucks and is easy to unload with standard equipment.

In conclusion, Liquid Lysine presents technological advantages and is particularly well adapted to the needs of today's producers of animal feeds. Liquid lysine gives the same animal performances as the crystalline product with an opportunity to improve the quality of the feed itself, the working environment and the logistics of handling and storage.

The future trend is for an increased application of liquid amino acids in the animal feed industry.