Table 2. Fecal apparent digestive utilization coefficients (DUCa) of dry matter and proteins, net energy and standardized ileal digestibility coefficients (SID) of the amino acids of the yeast extract L and the yeast.

	Yeast		P^2
	L[1]	S	
DUCa, %[3]			
Dry matter	89.8 ± 2.7	83.7 ± 2.8	0.014
Proteins	90.1 ± 2.3	77.5 ± 4.5	0.005
Energy	88.4 ± 5.5	81.6 ± 3.0	0.008
Net energy, MJ/kg[4]	9.4 ± 0.2	9.2 ± 0.4	0.3
SID, %[5]			
Lysine	87.2 ± 6.0	52.5 ± 16.3	0.003
Methionine	81.2 ± 6.9	53.6 ± 23.3	0.022
Methionine + Cysteine	55.5 ± 11.0	36.8 ± 17.0	0.1
Threonine	68.5 ± 13.0	23.5 ± 16.7	0.019
Tryptophan	72.9 ± 11.6	32.8 ± 21.0	0.011
Valine	76.4 ± 12.2	39.9 ± 18.3	0.015
Isoleucine	78.0 ± 11.7	36.6 ± 19.5	0.007
Leucine	75.2 ± 14.0	38.1 ± 19.,4	0.014
Arginine	81.9 ± 11.2	54.2 ± 16.3	0.037
Phenylalanine	74.9 ± 13.6	42.3 ± 20.2	0.020
Histidine	74.7 ± 5.5	55.9 ± 23.8	0.035

[1]*Bakery yeast extract used in Studies 1, 2 and 3.*
[2]P-*value of the Student test. The residual standard deviation is 2.8% for the DUCa of dry matter, 3.5% for that of proteins, 2.8 MJ/kg for digestible energy and 0.3 MJ/kg for net energy.*
[3]*Measured.*
[4]*Equation for the calculation of the net energy concentration (NE; CVB [9]): NE (MJ/kg) = (11.7 × digestible raw proteins + 35.74 × lipids + 14.14 × starch + 0.9 × sugars) + 9.6 × digestible NSP) / 1000; NSP = Organic matter – raw proteins – lipids – starch – sugars x CF_DI where CF_DI: mass correction factor to calculate the glucose equivalents of disaccharide concentration in animal feeds.*
[5]*The endogenous values were estimated according to the CVB tables [9].*

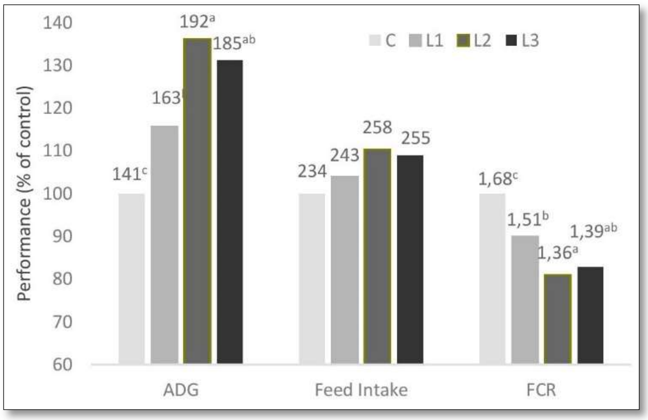

Figure 1. Growth performance based on the group 1 during the prestarter I phase (D1_D14)[2].

[1]*See Table 1.*

[2]*Different letters indicate the significant differences between the treatments P<0.05.*

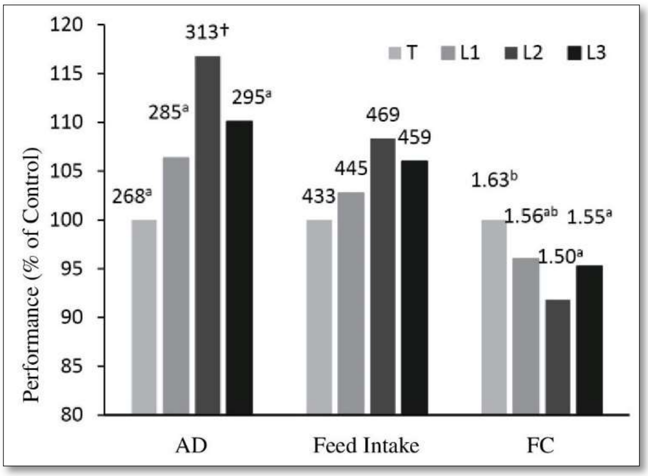

Figure 2. Growth performance based on the group 1 during the prestarter I and II phases (D1-D29)[2]

[1]*See Table 1.*

[2]*Different letters indicate the significant differences between the treatments P < 0.05, † indicates a tendency (P = 0.07).*

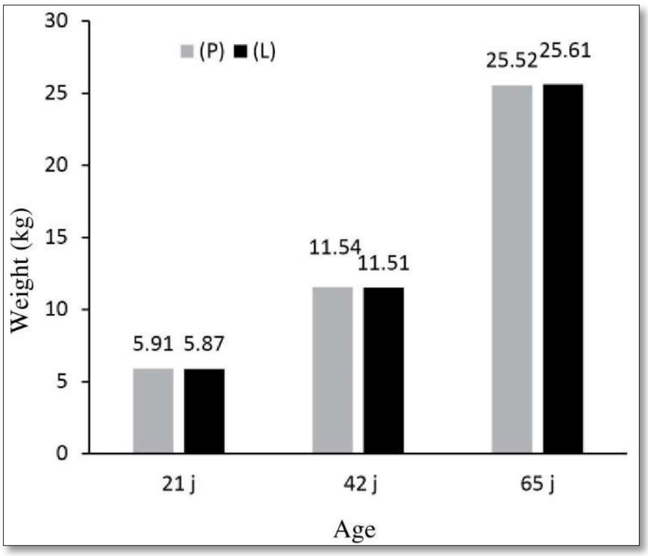

Figure 3. Average weight of the piglets at 21, 42 and 65 days old based on the batch.

DISCUSSION

A purified source of functional proteins must first and foremost be palatable with a high level of digestibility. It must also promote the rapid development of the digestive tract in the young, and strengthen their immune status. In these Studies, the yeast extract used had a minimum protein concentration of 63% of the fresh weight, a high level of amino acid digestibility and high rates of total nucleotides (7.7%) and glutamic acid (10.9%). The Study established a better digestibility of the amino acids contained in the yeast extract L. Several authors [8] have shown that the absorption of dipeptides and tripeptides was faster than that of their constituent AAs. Thus, the efficacy of the yeast extract L is explained first and foremost by its peptide composition, with 26% of free AAs and 38% of AAs of low molecular weight (< 0.9 kDa): the AAs can be transported through the brush border membrane of the intestinal epithelial cells, either in free form or in the form of dipeptides and tripeptides.

The high glutamic acid concentration (10.9%) of the yeast extract L also seems to play an important role, not just in terms of palatability and the taste acceptance of the prestarter I and II feeds, but also in gut development and, consequently, its performance [10,11]. In fact, it has been showed that the glutamic acid had palatability benefits [12]. The results obtained with the yeast extract L can therefore be explained in part by its high glutamic acid content. The addition of the extract L might also provide benefits similar to those of sow milk. Indeed, among the 20 free AAs contained in sow milk, glutamic acid is the most abundant, representing more than 50% of the total free AA concentration. Glutamine is an essential nutrient for the gut; around 30% of the total glutamine is used in the different intestinal tissues. It is linked to the promotion of the proliferation of enterocytes, the regulation of the tight junctions, which are the proteins that regulate the permeability of the intestinal epithelium, and is involved in the suppression of pro- inflammatory signaling pathways to protect the cells from apoptosis and cellular stress in normal and pathological conditions [13,14]. The results of several studies in animals suggest that dietary nucleotides might affect the gastro-intestinal tract by promoting the faster maturing of the tract, by modulating the intestinal microbiota and by activating the immunity strengthening cells. Although nucleotides are synthesized endogenously, it has been suggested that a nucleotide feed supplement could have a beneficial impact on the growth and development of the small intestine, lipid metabolism and hepatic function [15,16]. Thus, even if the nucleotides present in the yeast extract are present in the form of RNA, their presence might explain in part the positive effect on growth and the intake efficiency of the piglets.

CONCLUSION

Generally speaking, the yeast extract L used in the combination L2 produced better results than the other L groups. It is therefore when it is incorporated at 2% in the prestarter I feed used for the first 14 days and at 1% in the prestarter II feed used for the next 14 days that it is most effective, noting all the same that the diet inclusion programme will depend on the farm's nutritional programme, and that the optimum benefit of the yeast extract L supplement is obtained when the piglets are capable of eating between160 g and 200 g of the product over the first 28 days of the post-weaning phase.

The incorporation of the yeast extract L might enable nutritionists to formulate a non-animal protein feed as effective as those formulated with plasma proteins. Thus, thanks to the combination of its functional active ingredients, together with good palatability, the amino acid profile and a high protein and AA digestibility, the yeast extract L appears to represent a novel raw material for use in weanling pig feed.

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