Potato by-products as second-generation feedstuff for pig feed

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Introduction

Potato by-products are made up of whole and broken potatoes from the potato processing industry that are discarded from human consumption due to commercial criteria normally associated with their presence and size. Currently, part of the potatoes fraction is managed through verbal agreements between industries and farmers who collect them at low cost or assuming the logistics cost but without stablishing great hygienic controls.

Regarding its nutritional value, the potatoes by-products are considered a very energetic food mainly due to its starch content (between 60-80%) and its interesting content in protein, fibre and potassium. Therefore, and considering the requirements of pigs feeding, potatoes by-products are considered a raw material that fits perfectly with the requirements of pigs (Ncobela et al, 2017). However, the way in which these by-products are processed could have high impact on the nutritional value of obtained ingredients (Dom et al, 2017).

On the other hand, the pig sector is interested in replacing current raw materials such as soybean meal with other more sustainable ingredients locally sourced with the aim of betting on local products. This is aligned with the opportunity to obtain new feed ingredients from agri-food by-products.

Therefore, this study proposes a sustainable solution for reusing potatoes by-products as an alternative raw material to soybean meal for fattening pigs after applying an innovative stabilization process which ensures food security and the minimum hygienic conditions.

Material and methods

The stabilization process of potatoes by-products is of utmost importance due to its high moisture content. Since the initial humidity is 85%, a previous dehydration step is proposed by mechanical dehydration technologies (low energy consumption), to reduce the water content to 55%. The proposed mechanical dehydration technology is a filter centrifuge.

Once the humidity has been reduced to a maximum (approx. 55%), a final dehydration step is proposed through Flash dryer technology (with high efficiency energy use) to achieve the desired moisture content (less than 10%). The flash dryer technology allows instant, self-regulating and continuous drying of wet solids, as well as a low operating cost associated to this high thermal efficiency. This implies maximum energy efficiency and minimal environmental impact. This technology is also suitable for temperature-sensitive products due to this minimum heating of the solid during a short time of residence inside the dryer - fractions of a second - and to maintain their nutritional value and safely (food security). Hence, the methodology for adjusting the operational conditions of the stabilisation process is to carry out several pilot scale tests in which different ingredient prototypes are obtained and assessed.

The obtained potatoes by-products-based ingredient was characterized to assess its nutritional value. Digestibility test was carried out with the aim of determining its maximum level of inclusion. With this information, an experimental diet was formulated to meet all the nutritional requirement of the pigs. This experimental diet was iso-protein and isoenergetic compared to the commercial diet that was used as a control. Finally, a specific growth trial was applied with the aim of quantifying its nutritional efficiency, mortality, and growth indicators, compared to control diet. This growth trial was carried out with 106 pigs at a real pig farm in a real operational condition. Pigs were randomly distributed in two groups of 53 animals each. The two lots were distributed balanced according to their live weight. The test was extended during a complete productive cycle (with a duration of 161 days) in which the effective implantation of the feed was carried out. One lot received a commercial control diet and the other received the innovative diet with 5% of potatoes by-products in its composition. The animals were weighed at the beginning of the trial and at sacrifice. Likewise, a biweekly record

of the quantities of feed offered and rejected for each batch of animals has been kept. At slaughter, the classification of the channel assigned in slaughterhouse was recorded.

Finally, a sensory test of the obtained products from both lots was performed for their validation by an expert consumer panel.

Results and discussion

The initial moisture content of the potato by-products was 85 %. After the first mechanical dehydration with the centrifugal filter, a 56 % water content was reached and, finally, a 10 % moisture ingredient was produced with the last flash drying step.

The nutritional composition of potato by-products-based ingredient is shown in the Table 1:

Table 1. Nutritional value of potato by-products-based ingredient

Parameters	Unit	Value
Moisture	%	10.0
Ashes	%	2.7
Protein	%	7.2
Carbohydrates	%	79.7
Fiber		2.3
Crude fat	%	0.4
Starch	%	63.5

The ingredients that make up the commercial diet used as a control and the experimental diet with a 5 % inclusion of potato by-product ingredient are presented in Table 2:

Table 2. Experimental and control diet composition

Ingredients	Control diet (%)	Experimental diet (%)
Wheat	40.10	38.00
Corn	24.10	18.50
Green peas	10.00	10.00
Rapeseed flour	9.40	9.40
Corn germ	7.70	7.80
Barley	4.00	6.20
Soybean flour	1.80	1.80
Molasses	1.00	1.00
Calcium carbonate	0.83	0.73
Salt	0.36	0.40
Dicalcium phosphate	0.31	0.36
Ingaso ingredient	0.30	0.30
L-lysine	0.15	0.13
Potato by-products flour	0.00	5.00

With regards the **daily ingestion of feed**, it was observed that the animals of the group with 5 % of potato flour consumed more average feed than the pigs of the control feed group (2699 g / d vs. 2359 g / d, respectively), as it is shown in Figure 1.

Figure 1. Ingestion of feed (grams / day)

Regarding the **average daily gain data**, a higher average daily gain was observed in the animals of the group with 5 % of potato flour than in those of the control group (537 g / d vs. 509 g / d, respectively), as it is shown in Figure 2.

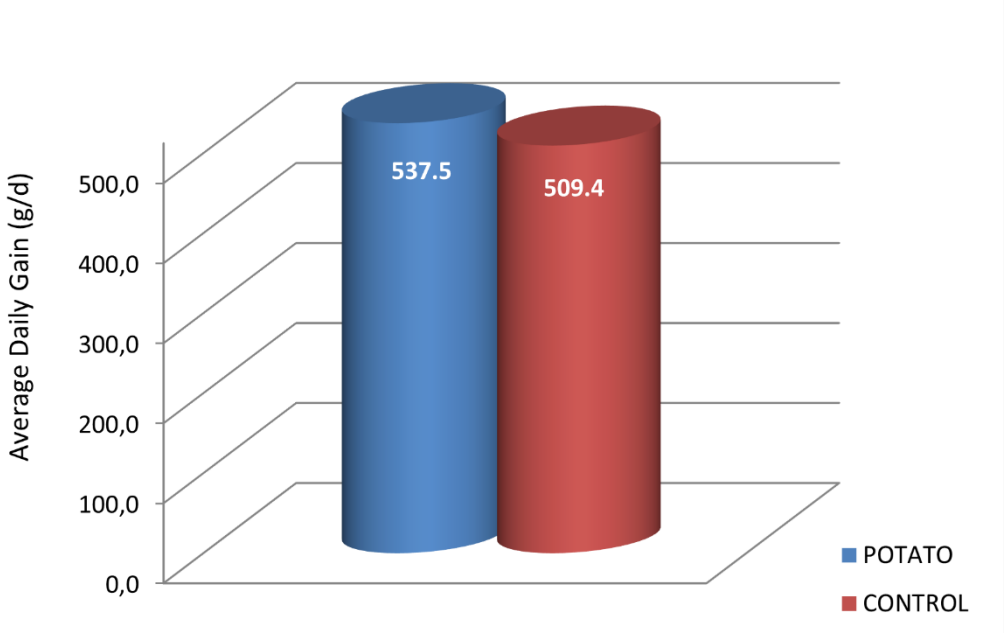

Figure 2. Average Daily Gain (grams / day)

It was observed that the **conversion rates** in both groups were very similar (5.30 vs. 5.21 for the 5 % of potato flour group and the control group respectively), as it is shown in Figure 3.

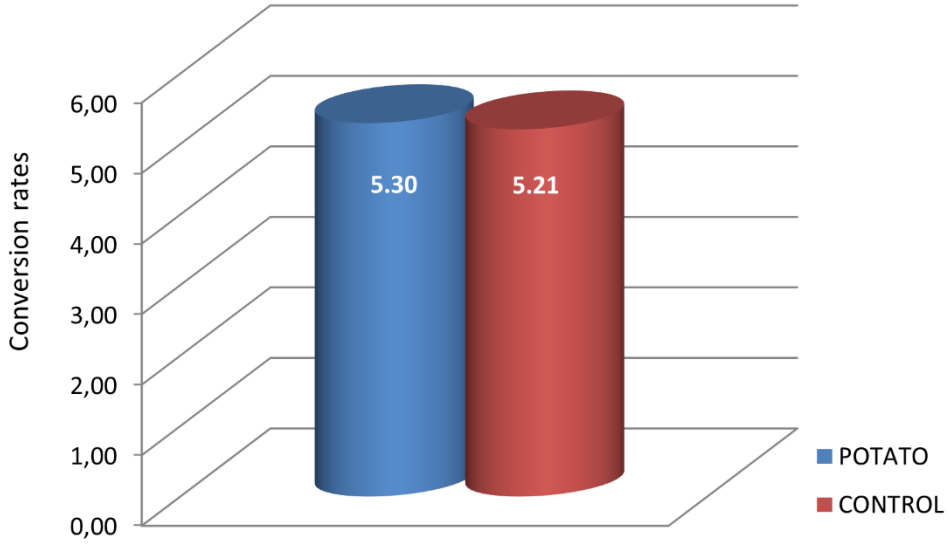

Figure 3. Conversion rates

On the other hand, a **higher mortality** was observed in the bait period in the control group with respect to the group with 5 % of potato flour (11.3% vs. 5.7%, respectively). The evolution of mortality over the months, a higher cumulative mortality could be observed in the control group from the third month of the trial, as it is shown in Figure 4.

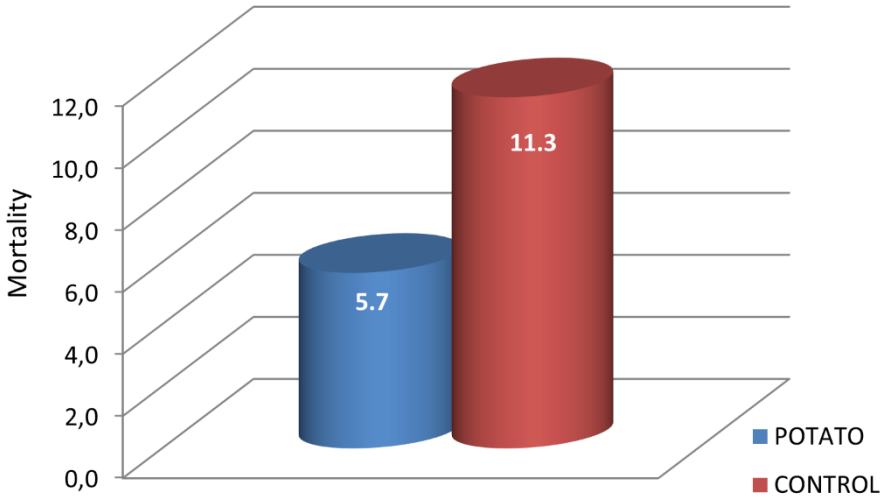

Figure 4. Mortality (%)

Finally, regarding the **sensory test**, a trend towards a small accumulation of liquid in the fillet, a greater presence of marbled meat and more resistance to biting was detected in the product fed with the experimental diet, but without significant differences between both groups.

Based on the data of the daily feed intake, the palatability of the experimental diet is adequate and does not affect feed intake. The average daily gain data and the conversion rates show better results in animals fed with the experimental diet than with the commercial diet, so it can be concluded that, in terms of nutritional efficiency, the inclusion of 5% of potato by-products in the diets do not involve differences in the nutritional value of the diets and does not significantly affect the fattening of pigs. Mortality is higher in animals fed with the commercial diet; therefore, immunosuppression cannot be associated with the experimental diet. Finally, the sensory results do not show significant differences between final products, so the final products should be accepted by the consumer.

Conclusion

In conclusion, potatoes by-products stand up as an alternative ingredient for pigs due to their availability in Europe, their nutritional characteristics and the results obtained in the growing trials. Hence, replacing current raw materials such as soybean with a more sustainable ingredient based on potatoes by-products would contribute to increase the competitiveness of pig farm sector by reducing the high dependence on current raw materials.

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