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FABACEAE AS AN ALTERNATIVE SOURCE OF PROTEIN IN THE PRODUCTION OF COMPOUND FEEDS IN THE OPINION OF POULTRY PRODUCERS AND PIG PRODUCERS

Key words: protein feeds, legumes, soybean meal, poultry producers, pig producers

ABSTRACT. This article aims to assess the feasibility of using native legumes as alternative sources of protein in compound feeds by poultry producers and pig producers. Data to achieve this objective came from a direct survey conducted in 2018, with twenty-three poultry and pig producers. Measures of descriptive statistics were used in the calculations. The collected information was analyzed and then described using descriptive statistical methods. The research used statistical data collected in the databases of the Central Statistical Office and the databases of the Institute of Agricultural and Food Economics. The obtained results were illustrated using graphical methods of data presentation. The study reveals that the main obstacles to the use of native legumes in animal nutrition, in the opinion of pig producers and poultry producers, include the share of anti-nutrients, problems with digestibility of legumes, low protein content in seeds, problems with production technology and the higher cost of compound feeds.

INTRODUCTION

Food security that includes the availability of plant protein is a major economic policy goal of all countries, hence the need to ensure diverse and reliable sources of it. However, the expansion of poultry meat production and pork global trade has triggered the process of replacing native legume protein in poultry and swine feed with the easily available and quality-competitive imported soybean protein. Also, the genetic improvements made in livestock breeding in recent years has resulted in a significant increase in their production potential. Currently, animals capable of high productivity are also very demanding in terms of animal nutrition and welfare. Protein is the main nutrient and building component for breeding animals, hence its fundamental importance in animal nutrition.

Plant proteins are a valuable source of amino acids for livestock, and thus are a key component of feed and have vital importance for EU agriculture. They are also increasingly consumed by humans as food, with an annual increase in their worldwide consumption of nearly 7 percent. However, there is a significant shortage of plant proteins in the European Union, hence the majority of the EU agricultural sector's needs are met through imports [cf. Jerzak, Śmiglak-Krajewska 2020, Śmiglak-Krajewska, Wojciechowska-Solis 2021].

This publication aims to assess the feasibility of using native *Fabaceae* as alternative sources of protein in compound feeds by poultry producers and pig producers.

LEGUME SEEDS AS A PROTEIN SOURCE FOR ANIMALS

Seeds of native legumes (large-seed legumes) can be an important source of feed protein. This is particularly relevant in the current situation of deepening deficit in national high-protein feed stores. The nutritional value and edibility of the seed depends mainly on the species, variety as well as climate and soil conditions. The feed qualities of the seeds from this group of plants are mainly determined by their high protein and essential amino acid content and high nutrient digestibility [Podleśny, Księżak 2009]. The protein content of legume seeds ranges from about 20% in peas to 45% in annual yellow-lupin seeds [Milczarek, Osek 2016]. A common feature of the protein from those seeds is the low content of the sulphur amino acids - methionine and cystine [Hanczakowska, Świątkiewicz 2015]. However, they contain a relatively high amount of lysine, which makes them a good addition to cereal-based feeds [Hanczakowska, Księżak 2012]. Feed suitability of legume seeds is also differentiated by phytates, tannins, proteolytic enzyme inhibitors and alkaloids in the case of lupins [Crépon et al. 2010]. The use of these components in feeds requires the inclusion of protein content, its nutritional value and associated effects obtained in livestock nutrition. The main requirement is the availability of large batches of homogeneous feed material on the market [Śmiglak-Krajewska 2018]. The differences in nutrient and anti-nutrient content are the reason for diverse uses of individual legumes as a protein source in livestock feed. Legumes (field beans, peas, lupines) can be a source of protein in compound feeds for adult poultry, swine, and cattle; they should not be used in the feeding of young poultry, piglets, and weaners [Grela 2020]. The use of 15-20% peas is permitted in compound feeds for pigs, weaners, and porkers, while up to 10% for breeding boars. Field bean cannot be used in the feeding of piglets and weaners, while in compound feeds for sows and porkers its permitted maximum content is 8 and 15%, respectively. For laying hens, however, the presence of legume seeds must not exceed 10-15%, while for broiler chickens – 5% in starter feeds [Mazur et al. 2020, after Brzóska 2008, Pastuszewska 1997].

Recently, there have been significant improvements in breeding new legume varieties. Seeds of the *Fabaceae* family have an increased protein content and reduced levels of antinutrients, and their feed value and suitability as components in compound feed for monogastric animals – pigs and poultry – have been improved. The obtained favorable changes in the nutritional value of legume seeds and the application of their treatment processes opened new prospects for their feed use in livestock production [Sońta et al. 2020]. Breeders and producers of slaughter animals use domestic sources of protein, such as sweet lupines, peas, and field beans. Many research works carried out in domestic and foreign centers confirmed the lack of negative effects of using moderate amounts of seeds of the *Fabaceae* family in the diet of animals on their basic production characteristics [Sońta, Rekiel 2017, Koivunen 2014].

HIGH-PROTEIN FEED MATERIAL MARKET

In the past few decades, there has been a shift in swine nutrition – from the traditional diet, which was dominated by livestock feeds, to a more efficient one using cereal grains, post-extracted meal, and/or concentrates and premixes [Rekiel et al. 2018]. The growing poultry production volume also increased the demand for high-quality manufactured feeds, balanced in terms of energy and protein. The demand for high-protein feed materials in Poland is marked by systematic growth. An increase in the intensity of milk production is also quite important, as it causes an increase in the consumption of high-protein feeds in dairy cows [Szostak et al. 2017].

Table 1. The volume of consumption of high-protein feed materials in 2015-2021

Specification	Consumption [thousand tonnes]					
	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021
Oilseed meal, including:	3,269	3,474	3,938	3,722	3,852	4,188
– soybean	2,311	2,248	2,423	2,383	2,647	2,633
– rapeseed	593	858	1,070	938	799	1,177
– sunflower	360	363	440	395	396	365
– others	5	6	6	7	11	12
Fishmeal	35	24	23	22	20	23
Legume seeds	467	383	373	315	337	447
Total	3,771	3,881	4,334	4,059	4,209	4,658

Source: own elaboration based on [IERiGŻ-PIB 2021, No. 42, 43, p. 25]

A variety of energy and high-protein components are necessary for feed production. Energy components may include mainly cereals, i.e.: rye, oats, barley, wheat, maize, and triticale. The group of high-protein components primarily includes oilseed (soybean, rapeseed, and sunflower) meals, legume seeds (peas, field bean, lupines), and meals of animal origin, including fish meal and meat meal [Jerzak et al. 2020]. There are some differences in terms of the amino acid composition of native legume seeds, however, these seeds are considered a good substitute for soybean meal in feeds. Nevertheless, the principle that such seeds cannot be the only protein component needs to be maintained.

As can be observed from the data summarized in Table 1, the demand for protein is met mainly by oilseed meals, which is the only larger-scale source of feed protein available. Consumption of high-protein feed materials in Poland in the 2020/2021 season was 4,658 tonnes and was higher by 23% compared to the 2015/2016 season. However, the balance is dominated by imported soybean meal, whose consumption remained at 2.2-2.6 million tonnes per year in the period between 2015 and 2020. Rapeseed meal consumption in the 2020/2021 season was 1.18 million tonnes and was nearly almost double compared to that of the 2015/2016 season.

Legume seed production and supply continue to play a minor role in the feed protein balance. In 2016-2020, oilseed meals had the largest share in terms of high-protein feed materials, averaging 91%. Legumes were second – from 7.8% in 2018 to 9.9% in 2016. The smallest share was observed in meals of animal origin – an average result of 0.5% (Figure 1).

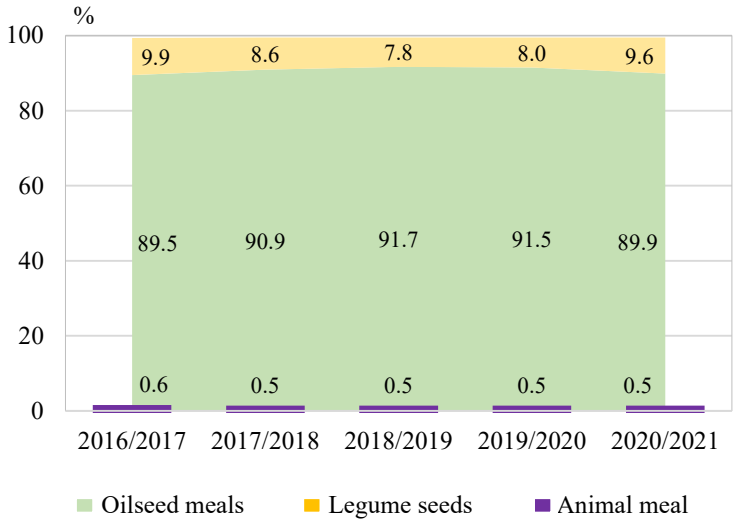

Figure 1. The structure of consumption of high-protein feed materials in 2016-2020
Source: own elaboration based on [IERiGŻ-PIB 2021, No. 42, 43, p. 25]

Domestic protein needs are met by importing soybean meal, mainly from South America. The volume of imports in 2016-2021 ranged from 2,283 tonnes in 2016 to 2,732 tonnes in 2020, and completely covered consumption (Figure 2). This result confirms the view that domestic animal feed production is heavily dependent on imported soybean meal, mainly from the American continent.

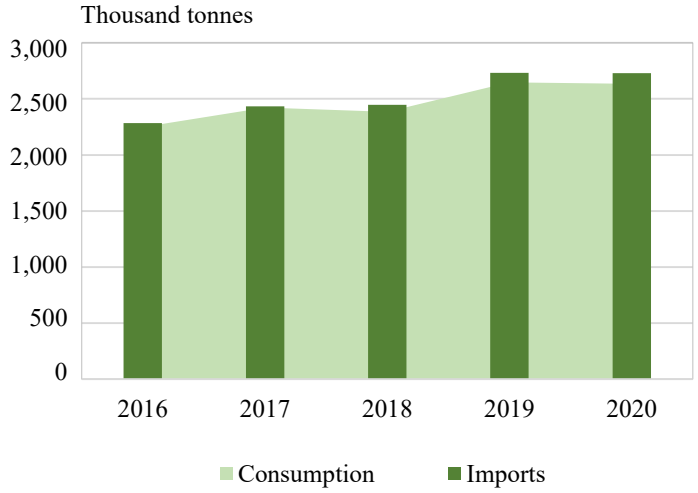

Figure 2. Imports and consumption of post-extracted soybean meal from 2016 to 2020
Source: own elaboration based [IERiGŻ-PIB 2021, No. 43, p. 25]

MATERIAL AND METHODS OF STUDIES

The results of a 2018 study conducted on a sample of twenty-three poultry producers and pig producers (9 poultry producers and 14 pig producers) were used for achieving the stated objective. This publication uses research conducted under the Ministry of Agriculture and Rural Development's Multiannual Programme "Increasing the use of domestic feed protein for the production of high-quality animal products in conditions of sustainable development" implemented from 2016 to 2020 [MRiRW 2019]. The selection of the sample was targeted and was prepared based on consultations with poultry producers and pig producers and on verification of the Register of General Veterinary Inspectorate. The measuring method was a direct survey, using a standardized questionnaire. The questions were asked using the rank method and the Likert scale. The collected information was analyzed and subsequently described using descriptive statistical methods. This article

was developed using the descriptive analysis of statistical data collected in the Statistics Poland (GUS) database, and the National Research Institute of Agricultural and Food Economics database. Measures of descriptive statistics were used in the calculations. The obtained results were illustrated using graphical methods of data presentation.

STUDY RESULTS

The profitability of livestock production, in addition to the price obtained for livestock on which the producer has no considerable influence, depends mainly on production results and costs incurred. In pig or poultry production, feed costs represent the largest share of total costs and may be as much as 60-80% [Siarkowski, Maciejewski 2005], especially in the recent period when grain prices remain remarkably high. On the other hand, excessive savings in terms of animal nutrition result in a significant decrease in production efficiency. Many livestock farm owners face the dilemma of whether to feed their animals based on feeds purchased from feed mills or to feed their animals based on their own compound feeds made on their own farm.

The survey revealed that 67% of pig producers used feeds prepared on their own farm to feed their animals and supplemented them with high-protein concentrates and vitamins. For poultry producers, the percentage was lower – 39% (Figure 3).

The main reasons for using their own compound feeds were mainly economic factors (57% of indications in the group of pig producers and 14% in the group of poultry producers), the availability of their own raw materials for the production of compound feeds (43% – pig producers, 29% – poultry producers) and the possibility of controlling the production process (36% – pig producers, 14% – poultry producers).

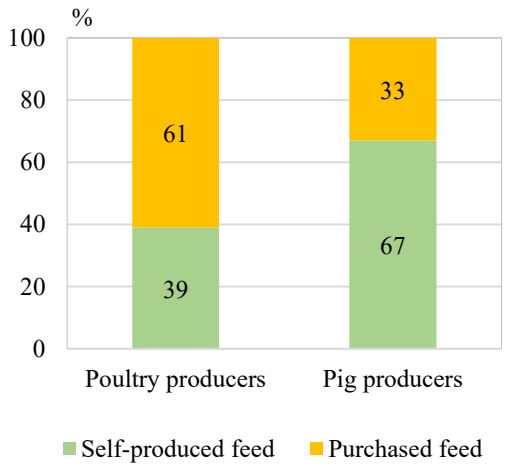

Figure 3. The structure of the use of compound feeds on farms

Source: own study based on survey data

Participants indicated trading companies or traders as the main source of feed supply (45% in the group of pig producers, 14% in the group of poultry producers) and purchase directly from the farmer (14% – poultry producers, 9% – pig producers). An assessment of the logistics of the supply of raw materials for the production of own feeds indicates that there are no problems in the current operation of the supply chain of raw materials for the production of own feeds. All participants stressed the strong dependence of domestic livestock production on imports of soybean meal and soybean seeds mainly from the American continent. Such dependence may pose a threat to the food security of Poland and many EU countries. This is particularly feasible in the event of a crisis situation on the American continent and the disruption of the plant protein supply chain for feed purposes. Imports could be significantly reduced by using domestic sources of protein, including seeds of large-seed legumes (peas, field beans, sweet lupines) that exhibit adequate protein content. Pig and poultry producers were therefore asked about the advantages and disadvantages of using legumes as an alternative source of protein in compound feeds.

In the opinion of pig producers, the main obstacle to the use of legumes in animal nutrition is the high proportion of anti-nutrients (36%). Anti-nutrients cause considerable limitations in the use of seeds in animal nutrition, as they negatively affect feed intake, feed utilization and growth rates. Anti-nutrients also exhibit harmful effects on animal health by damaging visceral organs and causing falls [Agrifirm 2020]. The result is increased economic losses for producers. Anti-nutrients also negatively affect protein digestibility

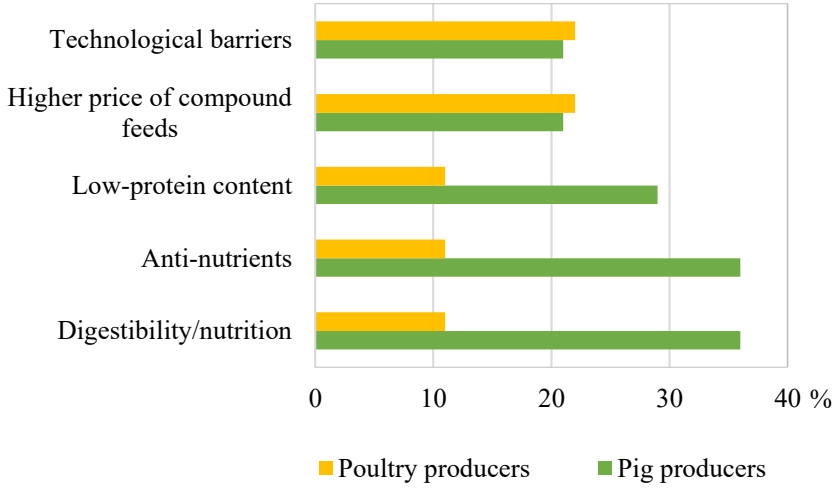

Figure 4. Disadvantages of the use of legumes as alternative sources of protein in compound feeds for pigs or poultry

Source: own study based on survey data

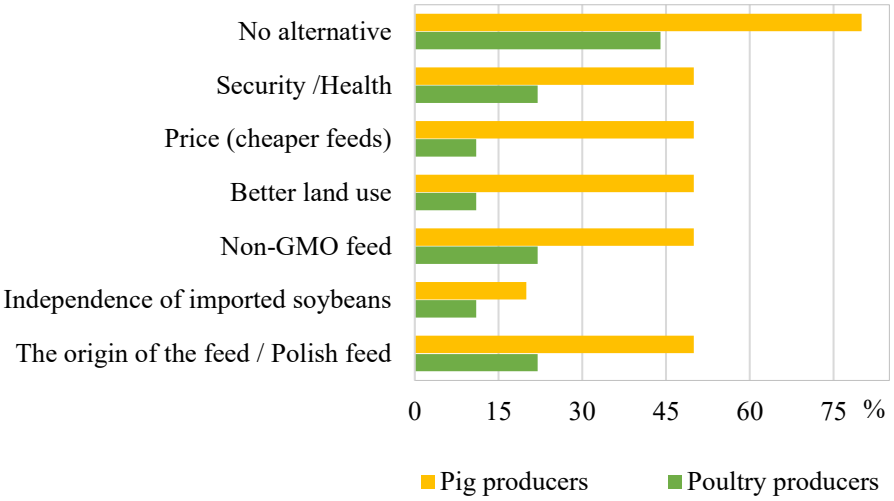

Figure 5. Advantages of the use of legumes as alternative sources of protein in compound feeds for pigs or poultry

Source: own study based on survey data

(36% of indications in the group of pig producers, 11% in the group of poultry producers). The protein of these plants is relatively high in lysine but poor in the sulphur-containing amino acids – methionine and cysteine [Dzwonkowski 2018]. Also in terms of tryptophan content, soybean meal significantly exceeds seeds of domestic legumes [Akande et al. 2010]. Twenty-nine percent of participants in the group of pig producers identified the lower protein structure of legumes compared to imported soybean meal as a disadvantage. Both groups of participants also indicated economic issues in the use of legumes in compound feeds (22% – poultry producers, 21% – pig producers). They believe that the costs of compound feeds based on native protein are significantly higher compared to feeds prepared based on imported soybean meal. The participants also indicated technological problems in preparing compound feeds using legumes (22%), and the lack of sufficient quantities on the market (Figure 4).

Producers were also asked about arguments in favour of using legumes as alternative sources of protein in compound feeds for poultry or pigs (Figure 5).

The advantages mainly included the independence of imported soybeans (33% – pig producers, 11% – poultry producers), the domestic origin of the feed and thus greater security (health) of compound feeds with the addition of legumes (22% – poultry producers, 17% – pig producers). Unfortunately, not all producers see native legumes as an alternative to soya. Forty-four (44) percent of poultry producers and 8% of pig producers indicated that legumes did not have any advantages that would make them use them in animal nutrition.

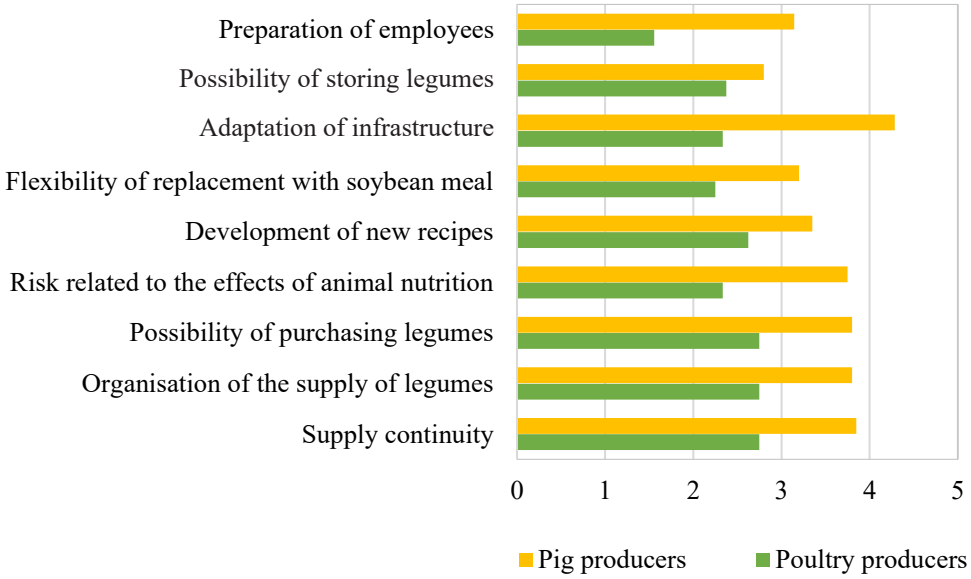

Figure 6. The assessment of conditions for the production of own feeds with the addition of legumes (ranks: from 1 – definitely the least important to 5 – definitely the most important)
Source: own study based on survey data

The assessment of conditions for the production of own compound feeds with the addition of legumes indicates the potential threats associated with the availability of legumes, which is directly related to the supply continuity and the comprehensive organisation of logistics processes (Figure 6). The participants also indicated the risk related to the effects of animal nutrition. Developing new recipes and adjusting the infrastructure may turn out to be ineffective in the absence of raw materials for processing. Therefore, the production volume of legumes – which guarantees the supply continuity and the consistency of the composition of used compound feeds – is a problem of fundamental importance.

The producers were also asked about the effect of the use of feeds with the addition of native legumes on the weight gain of breeding animals and on the quality of the final product (meat). The participants indicated, among other things, lower growth rates in animals fed with feeds with the addition of legumes (42% in the group of pig producers, 27% in the group of poultry producers), potential animal diseases, and thus lower quality of the final product, e.g. fatter product. The obtained results clearly indicate the lack of knowledge and experience (57% of pig producers, 22% of poultry producers), and thus the intuitiveness of the answers provided.

SUMMARY

According to the pig producers and poultry producers, the main obstacles to the use of native legumes in animal nutrition include the share of anti-nutrients, problems with digestibility of legumes, low protein content in seeds, problems with production technology and the higher cost of compound feeds. However, by following nutritional recommendations, the use of legume seeds will not adversely affect animal health, feed intake and use, and it is even possible to obtain good production results.

On the other hand, the most important arguments of the participants in favour of using legumes as alternative sources of protein in compound feeds for poultry or pigs included independence of imported genetically modified soybeans, independence of suppliers, and security (health) of compound feeds with the addition of legumes. The assessment of conditions for the production of own compound feeds with the addition of legumes indicates the potential threats associated with the availability of legumes, which is directly related to the supply continuity, the comprehensive organization of logistics processes, and nutritional consequences for animals.

In conclusion, the use of compound feeds containing various domestic sources of protein, such as post-extracted rapeseed meal, and seeds of the *Fabaceae* family (peas, lupines, field bean), may be a beneficial alternative to compound feeds based on imported post-extracted soybean meal. The limitation, however, may be the availability of an adequate amount of the levelled material on the market, which will cover the demand for feed protein.

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ROŚLINY BOBOWATE JAKO ALTERNATYWNE ŹRÓDŁO BIAŁKA W PRODUKCJI MIESZANEK PASZOWYCH W OPINII PRODUCENTÓW DROBIU I TRZODY CHLEWNEJ

Słowa kluczowe: pasze wysokobiałkowe, rośliny strączkowe, śruta sojowa, producenci drobiu, producenci trzody

ABSTRAKT

Głównym celem opracowania jest ocena możliwości wykorzystania rodzimych roślin strączkowych jako alternatywnych źródeł białka w mieszankach paszowych przez producentów trzody chlewnej i producentów drobiu. Dane do realizacji postawionego celu pochodziły z wywiadu bezpośredniego przeprowadzonego w 2018 roku, którym objęto 23 producentów drobiu i trzody chlewnej. Do badań wykorzystano dane statystyczne zgromadzone w bazach GUS i Instytutu Ekonomiki Rolnictwa i Gospodarki Żywnościowej. W obliczeniach wykorzystano miary statystyki opisowej. Otrzymane wyniki zilustrowano graficznymi metodami prezentacji danych. Z przeprowadzonych badań wynika, że głównymi barierami wykorzystania rodzimych roślin strączkowych w żywieniu zwierząt, w opinii producentów, były: udział substancji antyżywieniowych, problemy ze strawnością roślin strączkowych, niska zawartość białka w nasionach, problemy z technologią produkcji oraz wyższy koszt mieszanek paszowych.

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