GRAPE BY-PRODUCTS AS BIOACTIVE SUBSTANCES IN ANIMAL NUTRITION: A REVIEW

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Abstract

Modern animal nutrition and feeding is oriented in feed additives right now. There are many different groups and categories of feed additives like probiotics, prebiotics, acidifiers, as well as enzymes. Except those groups, there are some by-products from the agricultural industry with potential to be feed additives. In this way, agricultural production should be more environmental. In the World, there is a grape production over 60 million tons per year. From this production, there are more than 9 million tons of by-products, mainly as pomace and stalk. Many studies published in the World shows, those grape by-products are sources of organic nutrients, minerals, as well as different bioactive substances with beneficial effect on animal organisms. Grape pomace is rich in many nutrients content like crude protein, amino acids, crude fat, essential polyunsaturated fatty acids, crude fibre, NDF, ADF or minerals, like calcium (Ca), potassium (K) or copper (Cu). Dry matter and organic matter digestibility ranged between 50 and 80 %. On other hand, pomaces good sources of fenolic acids, resveratrol, lignans or flavonols (quercetin), flavons, flavanols, izoflavons, antocyanins and others. As many reports shows, grape by-products stimulate feed intake, body weight, daily gain, as well as feed conversion ratio in ruminants nutrition. In non-ruminants nutrition, by-products from grapes processing have positive effect on growth performance, total apparent digestibility and potentially in meat quality. However, on the base of many published reports, grape by-products haven´t negative effect on health status of animals. Grape pomace bioactive substances have a potential for use in animal nutrition as feed additives with strong stimulative and protective effects. With bioactive substances can grape pomace help to better nutrients utilization from feed rations. As some studies shows, organic matter digestibility of grape pomace in very close to the hay. Adequate feeding of pomaces haven´t negative effect on animal metabolism through blood serum biochemical indicators.

Keywords: *nutrition, additives, by-products, effect*

1. INTRODUCTION

In the World, there is grape by-products production around 9 million tons per year (Katalinic et al. 2010). These organic residues have drawn increased attention for many positive effects as antioxidant agents, antimicrobial effects and others (Mildner-Szkudlarz et al. 2013 & Park et al. 2008). By-products as grape skin and seeds, of pomace are increasingly used to obtain functional food ingredients (Bhise et al. 2014). As Gálik et al. (2019) reported, grape pulps, skins, as well as seeds have potential to be feed additives in livestock nutrition. By-products from grape industry are rich in the content of some organic nutrients, many minerals and many active substances. As feed additives, mainly pomace and seeds can improve nutrients utilisation from the feed ration or feed mixture. Actually, only limited papers were focused with the grape by-products supplementation in feed rations or feed mixtures for ruminants (mainly cattle and sheeps) and non-ruminants (mainly poultry). By-products from the wine industry are rich in the content of crude protein, crude fibre, as well as neutral detergent fibre. Generally, grape by-products are valuable sources of energy and proteins for animals. However, *in vitro* dry matter digestibility ranged from 30 to 90 % and crude protein from 50

to 80 % respectively (Molina-Alcaide, Moumen & Martin-Garcia 2008). Dry matter digestibility of several grape pomace varietes should be very low, around 30 or 40 % (Famuyiwa & Ough 1982). Grape by-products are rich in the content of several flavonoids such as monomeric flavanols, dimeric, trimeric, and polymeric procyanidins, and phenolic acids (Bhise et al. 2014).

2. THE CONTENT OF BIOACTIVE COMPOUNDS

Content of nutrients in grape by-products is very specific, affected by factors like variety, stage of maturity, environmental factors and others. In by-products, there is a high lignin content and very low content of crude proteins. However, there are big differences in the content of minerals in grape pomace or grape skin. Grape pomace is rich in many nutrients content like amino acids, crude fat, essential polyunsaturated fatty acids, NDF, ADF, as well as minerals like calcium (Ca), potassium (K) or copper (Cu) (Gálik et al. 2018a). Marchiani et al. (2016) reported, the in grape pomace (in powder form), crude protein content is typical between 10 and 13 %, crude fat between 4 and 7 % and ash around 5 %. However, there are big differences in nutrients content in grape by-products from different varietes of *Vitis vinifera* (Gálik et al. 2019). Differences in the content of some nutrients are in white or red varietes. In red varietes, the crude protein content is little beat higher, between 12 and 18 %, however, also higher content of crude protein, higher than 30 % (Nardoia et al. 2017). Grapes and grape by-products are rich in the content of many specific compounds, bioactive compounds like anthocyanins, flavanols, flavonols and resveratrol as most grape polyphenols. These compounds possess many biological activities, such as antioxidant, antiaging and antimicrobial properties. There are some differences in the content of bioactive compounds like polyphenols in different parts of plant. As table 1 shows, there are some typical compounds contains as the same in seed, skin, as well as in leaf. Grape pigments are accumulate mainly in skin, flavonoids mainly in grapes, especially in seeds or stems (Xia et al. 2010).

Part	Compound	Source
Seed	Gallic acid, catechin, epicatechin	Pastrana-Bonilla et al. 2003
Skin	Egallic acid, myricetin, quercetin, kaempferol, trans-resveratrol	Pastrana-Bonilla et al. 2003
Leaf	Myricetin, egallic acid, kaempferol, quercetine, gallic acid	Pastrana-Bonilla et al. 2003
Stem	Rutin, quercetin, astilbin, resveratrol	Markis et al. 2008

Table 1. Content of some bioactive compounds in grapes

As a sources of bioactive compounds, Pastrana-Bonilla et al. (2003) analyzed grapes from 10 different cultivars of grapes. Authors found big differences in phenolic content and antioxidant capacity. In the skins, ellagic acid, myricetin, quercetin, kaempferol and trans-resveratrol are the major phenolics. In the grape, ellagic acid is the major component. And in the leaves, high content of myricetin, ellagic acid, kaempferol, quercetin and gallic adic is typical. Analysis of specific compounds content and antioxidant capacity of different grape varietes was published by Ky et al. (2014) too. Authors analyzed six different varietes of French grapes. They found, that in seeds, high content of total tannins is typical, and catechin also. In grape pomace seeds, content of total tannins is generally lower, as well as the content of catechin and epicatechin.

Grape pomace	DM	CP	NDF	DMD	OMD	Source
	%			%		
Dried	49.7	13.2	50.40	34.50	24.70	Pirmohammadi et al. (2007 a,b)
Silage	22.5	14.4	69.30	19.50	19.50	Zalikarenab et al. (2007)

Table 2. Nutrients composition of grape pomace

3. USING IN ANIMAL NUTRITION

There are many studies published with the effect of grape by-products in animal nutrition and production. Mainly grape pomace was studied. As Chikwanha et al. (2019) reported, different dietary red grape pomace intake in lambs affect dry matter intake. However, there were insignificant effects on meat quality. But percentage in diet is very important. As Gálik et al. (2018c) reported, grape pomaces are rich in the content of many nutrients, as well as in the content of some antinutritive compounds. These means, that the effect of grape pomace from the nutritional and productional point of view is affect mainly by the amount of daily intake. Content of nutrients in grape by-products are affected by many factors. Generally, these by-products are rich in the content of crude fibre, as well as acid detergent fibre and neutral detergent fibre, and in the content of phenols and total tannins (Besharati & Taghizadeh 2009). However, the quality of many nutrients is interesting from the animal nutrition and feeding point of view (Gálik 2018a,b). Many published papers in this area analyzed red wine varietes. As Zhao et al. (2018) published, wine grape pomace provides a rich source of polyphenols that can stimulate the production of lambs. Supplementation of grape pomace till 10% increase body weight, daily gain, and reduce feed to gain ration. In technological meat quality point, there wasn´t effect of grape pomace. Grape pomace is rich in natural antioxidants content, using as feed for animals is limited for the phenolic compounds content. However, grape pomace supplementation into the diet of lambs would not have negative effect on the suckling lambs meat quality (Gómez-Cortés et al. 2018). Possible using of grape pomace in sheep and dairy cows feeding were published by Nistor et al. (2014). In these experiment, dosages from 100 to 150 g per day in diet of Tsigai lambs were analyzed. Better results in body weight, total weight gain and weight gain were found only in the lowest concentration of grape pomace (100 g) with the comparison to control group. In the trial with Romanian spotted dairy cows, dosages from 3 to 5 kg per head and day were analyzed. When compare to control group, from groups with 3 and 4 kg of grape pomace, higher milk yield was found with a tendency of higher milk protein and fat content. However, high fiber, lignin and tannins content decrease nutrients digestibility (Nistor et al. 2014). In another experiment, Voicu et al. (2014) tested the effect of dietary dry grape pomace on the performance and health state of fattening Romanian Spotted steers. Authors didn´t find negative effects of grape pomace supplementation on health status of animals. Differences in body weight gains, feed conversion ration, as well as feeding efficiency were insignificant. Only differences in some plasma indicators were significant. Results of many trials and studies shows, that grape by-products, mainly grape pomaces are interesting sources of some nutrients and minerals for animal nutrition. However, these by-products are rich in some specific compounds content like tannins or phenolic substances. This means, that daily intake, or dosage is very important from the production and digestibility point of view. Lower concentration should be beneficial, higher depressive. Except of nutrients content, grape by-products (mainly pomace) are sources of many potential bioactive compounds with positive effect on feed ration nutrients utilization (Gálik et al. 2018a).

Aditya et al. (2018) examined the effect of grape pomace on growth performance, apparent total tract digestibility, blood profile and meat quality in broilers fattening. They analyzed different dietary intake. Authors found insignificant effect of grape pomace on body weight gain, however, authors found significant effect on body weight gain in periods from day 0 till 7 and from day 8 till 14. Grape pomace increased nutrients utilization from feed mixture except the highest concentration in feed mixture. Grape pomace doesn´t affect nutrients content in meat, but reduce serum cholesterol content

in comparison with control group of animals. Aditya et al. (2018) found insignificant effects of grape pomace on carcass traits of broiler chickens. Viveros et al. (2011) reported, that grapes are typical with higher content of phenolic compounds with the possible modulate effect on the gut activity as well as modify the gastrointestinal tract structure and functions. Experimentally, authors analyzed the effect of grape pomace and extract of grape seed in the diet of broilers on performance. Performance wasn´t affect by grape pomace, however extract of grape seeds reduce weight gain of animals. There was analyzed a tendency of lower feed intake in animals fed by feed mixtures supplemented with grape pomace and extract of seeds. Probably, tasty was problem. In another experiment, Nardioa et al. (2017) tested grape seed, grape skin and grape pomace on broilers meat quality. Authors found, that composition and microbial quality of raw chicken breast meat were not affected. Also, crude protein and crude fat contents weren´t affect after grape seed, grape skin or grape pomace supplementation in complete feed mixtures. As Nardoia (2016) published, grape by-products, mainly grape pomace is interesting source of polyphenols with high antioxidant activity. In broiler chicken nutrition, grape by-products can partially replace vitamin E in diets and can improve poultry performance and welfare. Only grape skin addition into broilers diet reduce daily body weight gain and feed conversion ratio. However, grape by-products increase plasma α-tocopherol concentration, and improve the stability of meat to lipid oxidation. In another trial Pascariu et al. (2017) analyzed different by-products from wine industry in broilers fattening. Authors found significant positive effect on body weight gain and better feed conversion ratio.

4. CONCLUSIONS

Grape by-products are rich in the content of many nutrients, organic nutrients, minerals, as well as some biological active compounds. In these organic residues, interesting content of energy and crude protein can be found. Except of organic nutrients, grape by-products are rich in the content of flavonoids. However, grape pomace is interesting source of nutrients with the potential to be used as feed additive in animal nutrition. Crude fat with high percentage of unsaturated fatty acids, higher content of amino acids, Ca, K and Cu is typical. Digestibility, nutrients utilization from grape by-products is limited for the content of tannins and some antinutritive compounds. There are big differences in content of nutrients in different varieties, mainly in white or red varieties. Additional, regional and agro-climatic differences can be found. But, by-products from the grape industry have been classified as potential feed additives in animal nutrition mainly from the nutritional point of view. However, for more information and verification, additional research is needed, like feeding trials with ruminants and non-ruminants.

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