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Do olive polyphenols negatively affect nutrient digestibility in pigs?

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Abstract

It is widely accepted that olive (*Olea europaea* L.) polyphenols (OP) have many favourable properties (e.g. antioxidative, antimicrobial, antifungal). OP can improve the growth and nutrient digestibility of animals via affecting digestion and health, even though they could negatively affect the mineral absorption by forming insoluble complexes with minerals in the intestine. In the present study, the effects of a dietary olive leaves extract (OLE) on nutrient digestibility in pigs were studied. Twenty-four weaned castrated male piglets were fed a no supplemented (C) or a supplemented diet with three different levels of OLE (O1, O2 and O3: 3.84 mg, 38.4 mg, 96 mg hydroxytyrosol equivalents/day, respectively). Retention and apparent total tract digestibility (ATTD) of dry matter (DM), crude protein (CP), crude fat (CF), organic matter (OM), nitrogen free extract (NFE), ash, neutral (NDF) and acid detergent fibres (ADF), gross energy (GE), Ca, P, Mg, Fe, Cu, Zn, K and Na were measured. Results showed that OLE lowered the retention of Fe and K, and revealed a numerical tendency to lower the retention of Cu and ATTD of Fe and Cu. In conclusion, a low dietary supplementation of OLE has no effect on the digestibility and retention of major nutrients, although some minor negative effects on mineral digestibility can be present.

Keywords: nutrient digestibility, olive polyphenols, pigs

Introduction

Olive (*Olea europaea* L.) polyphenols have many positive effects on human health and possibly in farm animals (Botsoglou et al., 2012; Paiva-Martins et al., 2014a). A limited number of studies performed in pigs showed that olive leaves can suppress lipid peroxidation (Botsoglou et al., 2012; Leskovec et al. (unpublished)). In spite of this, in others they did not have any favourable effect on oxidative stress (Paiva-Martins et al., 2014a), productive parameters (Botsoglou et al., 2012) and nutrient digestibility (Paiva-Martins et al., 2014a). Since olive leaves have a low energy content and can deteriorate nutrient digestibility (Paiva-Martins et al., 2014b), the use of extracts could ameliorate the negative effects and retain the favourable properties of olive polyphenols (OP). On the other hand, it is well known that some polyphenols

may negatively affect the bioaccessibility of Ca, Mg, Mn and Cu (Vitali et al., 2008), as well as of non-haem Fe. Olive polyphenols exert very strong antimicrobial and antifungal activities (Pereira et al., 2007), and could potentially influence animal performance, health and nutrient digestibility. Therefore, the aim of the present study was to evaluate the effects of the inclusion of different levels of an olive leaves extract (OLE) in a diet high in linseed oil on nutrients digestibility of pigs.

Materials and methods

Twenty-four individually penned commercial fattening pigs (14.2 ± 1.08 kg at the beginning of the excreta collection) were used (six animals per group). The same basal diet was fed to all the groups: not supplemented (group C) or supplemented with OLE at a level that provided 3.84, 38.4, or 96 mg hydroxytyrosol equivalents/day (groups C1, C2 and C3, respectively). The trial lasted twelve days, seven of adaptation and five of experimental period during which excreta and urine samples were collected daily. Feed consumption, excreted faeces and urine were monitored and collected daily. Analyses of dry matter (DM), crude protein (CP), crude fat (CF), organic matter (OM), nitrogen free extract (NFE), ash, neutral detergent fibre (NDF), acid detergent fibre (ADF), gross energy (GE), Ca, P, Mg, Fe, Cu, Zn, K and Na were conducted in the feed, excreta and urine. The retention and apparent total tract digestibility (ATTD) were also calculated. All the experimental protocols were approved by the Animal ethics committee of the Veterinary Administration of Slovenia. The GLM procedure of SAS/STAT programme was used for statistical analysis, and a Tukey-Kramer multiple-comparison test to test the differences between groups.

Results

No differences were obtained in the initial and final body weights, weight gain, feed conversion ratio, and daily faeces and urine excretion (data not shown). The supplements did not have an effect on retention and ATTD of CP, CF, NFE, NDF, ADF (Table 1), and on DM, OM and GE (data not shown). Supplementation with OLE caused a lower retention of Fe in group O3 in comparison to C, and a lower retention of K in group O3 in comparison to O1. Also, group O3 lowered the retention of Cu and the ATTD of Fe and Cu (Table 2), even though the difference was only numerical.

Table 1. Retention and apparent total tract digestibility (ATTD) of principal nutrients in pigs fed olive leaves extract-supplemented feed

Parameter		Group				SEM	P-value
		C	O1	O2	O3		
CP	Retention (g)	79.9	77.7	75.8	76.6	1.68	0.361
	ATTD (%)	89.4	90.1	91.3	89.6	0.54	0.121
CF	Retention (g)	62.3	62.2	62.4	60.9	0.64	0.314
	ATTD (%)	96.3	96.4	96.9	96.4	0.24	0.343
NFE	Retention (g)	177.5	172.8	191.4	182.3	6.25	0.239
	ATTD (%)	79.2	77.4	85.1	82.4	2.81	0.275
NDF	Retention (g)	27.5	27.3	27.1	25.9	0.76	0.489
	ATTD (%)	71.2	71.6	71.7	70	1.78	0.892
ADF	Retention (g)	6.4	6.8	7.3	6.6	0.46	0.61
	ATTD (%)	56.1	58.1	61.3	56.3	3.62	0.734
Ash	Retention (g)	19.8	19.2	19	18.8	0.46	0.455
	ATTD (%)	76.5	75.7	75.9	75.7	1.54	0.98

C - control diet; O1, O2, O3 = 3.84 mg, 38.4 mg, 96 mg hydroxytyrosol equivalents/day, respectively; CP - crude protein; CF - crude fat; NFE - nitrogen free extract; NDF - neutral detergent fibre; ADF - acid detergent fibre; [a,b] Different superscripts within a row indicate significant difference ($P<0.05$).

Table 2. Retention and apparent total tract digestibility (ATTD) of minerals in pigs fed olive leaves extract-supplemented feed

Parameter		Group				SEM	P-value
		C	O1	O2	O3		
Ca	Retention (g)	3.37	3.26	3.49	3.2	0.09	0.202
	ATTD (%)	77.4	76.1	79.6	77	1.98	0.664
P	Retention (g)	2.07	2.15	2.07	2.07	0.08	0.834
	ATTD (%)	65.1	65.5	64.7	65.4	2.2	0.993
Mg	Retention (g)	0.26	0.24	0.25	0.22	0.02	0.661
	ATTD (%)	37.7	35.4	35	33.1	2.75	0.701
Fe	Retention (mg)	41.2^{b}	28^{ab}	28^{ab}	22.9^{a}	4.39	0.052
	ATTD (%)	27.5	20.2	19.6	17.3	2.98	0.126
Cu	Retention (mg)	9.83	9.52	6.67	4.28	3.09	0.547
	ATTD (%)	12.66	12.81	9.32	6.45	3.51	0.529
Zn	Retention (mg)	29.5	35.1	32.8	34	3.9	0.766
	ATTD (%)	29.9	33.4	31.5	33.7	3.66	0.861
K	Retention (g)	2.41^{ab}	3^{b}	2.4^{ab}	2.35^{a}	0.16	0.035
	ATTD (%)	88.8	90.2	89.7	90.1	0.74	0.535
Na	Retention (g)	0.74	0.68	0.69	0.66	0.05	0.65
	ATTD (%)	89.9	90.9	91.5	89.4	2.43	0.923

Groups nomenclature as in Table 1; ^{a,b} Different superscripts within a row indicate significant difference ($P<0.05$).

Discussion

The inclusion of the OLE in diets for pigs did not affect any of the growth parameters, showing that extracts could be an alternative to olive leaves. This was somehow

expected since the same energy level was provided for all the experimental groups. Obtained results are similar to those reported by Botsoglou et al. (2012), in which no differences in growth performance in pigs supplemented with 1% of olive leaves were reported. However, Paiva-Martins et al. (2014b) observed reduced growth at higher supplementation level (5%), which could be explained by the fact that diets were not isoenergetic.

The OLE did not affect the digestibility of principal nutrients, showing that olive polyphenols do not seem to lower nutrient digestion and absorption. This is different than what Paiva-Martins et al. (2014b) reported, as in their study olive leaves diminished the digestibility of CP and CF, although the level of inclusion was higher than in the present trial. The digestibility of ash and macro-minerals (Ca, P, Mg) was not affected by OLE, showing opposite results than in some *in vitro* studies reporting that polyphenols can lower the bioaccessibility of macro-minerals (Vitali et al., 2008). Possibly, the discrepancy lays in the amount and type of polyphenols. On the other hand, the highest dietary level of OLE deteriorated the retention of Fe and K, and showed a numerical tendency to lower the retention of Cu and the ATTD of Fe and Cu. Possibly polyphenols formed complexes with metal cations, especially with Fe and Cu, and thus reduced intestinal absorption, as it is the case in humans (Bravo, 1998).

Conclusions

The OLE did not have any major effect on the principal nutrient retention and/or digestibility, and could be therefore safely used as a feed supplement. Only some minor effects were observed on the digestibility of Fe, Cu and K, suggesting that OP form non-absorbable complexes with minerals, and thus deteriorate the retention and/or digestibility.

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