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Short communication

Feeding of wheat middlings in lamb total mixed rations: Effects on growth performance and carcass traits

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ABSTRACT

Little scientific information is available that evaluates wheat middlings (WM) as corn grain substitute in lamb diet. The objective of this work was to evaluate the effect of feeding WM in total mixed rations (TMR) on lamb performance and carcass characteristics. Forty Comisana breed male lambs (13 ± 0.5 kg BW) were allocated randomly to two isocaloric and isonitrogenous diets. Two pelleted TMR were formulated: control diet contained 400 g/kg of dry matter (DM) of corn as main starch source, whereas experimental diet contained 600 g/kg DM of WM. Lambs were slaughtered after fifty days of feeding trial and carcass data were collected. In order to evaluate *in vivo* digestibility of TMR, four adult Comisana rams were placed in metabolic cages and their individual faeces and urine were collected, and indicated differences for NDF and ADF fractions. Results from growth trial of lambs showed that final live weight and gain as well as feed conversion ratio were improved by WM in diet (P=0.035). In slaughter trial, none of the parameters studied were influenced by dietary treatment, except for slaughter weight and cold-carcass dressing that were improved in lambs fed WM (P=0.047 and P=0.042, respectively). Additionally, WM diet had no effect on lamb carcass traits. As result, WM maintained lamb performance and had no negative effect on lamb performance and carcass traits. Maximizing the use of WM may become economically feasible for lamb feeders when prices turn favorable compared to conventional dietary ingredients such as corn.

1. Introduction

By-products from the wheat industry are increasingly available in many countries. Wheat middlings (WM) are by-products of the wheat milling process and are used for animal feed. They consist mostly of wheat pericarp, germ, and a small amount of endosperm tissue from various mill streams including the bran, shorts, germ, and flour streams (Reed et al., 2006). This by-product contains the offal from the aforementioned mill streams resulting in an approximate composition of 130–170 g/kg crude protein (CP), 80–90 g/kg crude fiber, 300–440 g/kg neutral detergent fiber (NDF) (Cromwell et al., 2000; Tufarelli and Laudadio, 2011). Due to the mixture of coarse and fine particles of WM, and its highly fermentable carbohydrates, WM must therefore be evenly mixed in ruminant rations (ZoBell et al., 2003).

Wheat middlings have been fed to livestock species such as poultry (Laudadio et al., 2011), swine (Kim and Lei, 2005), dairy cattle (Bargo et al., 2006) and ewes (Tufarelli and Laudadio, 2011). In particular, WM fed to beef and dairy cows in comparison

Abbreviations: ADF, acid detergent fiber; ADG, average daily gain; aNDF, neutral detergent fiber; BW, body weight; CP, crude protein; DM, dry matter; ME, metabolizable energy; NE_L, net energy for lactation; NFC, non-fiber carbohydrate; OM, organic matter; TMR, total mixed ration; WM, wheat middlings.

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Table 1
Ingredient and chemical composition of diets containing wheat middlings (WM) in TMR fed to lambs.

Ingredients, g/kg as fed	Diet		
	Wheat middlings[a]	Control diet	WM diet
Wheat middlings		–	600.0
Coarse corn		400.0	–
Oat hay		200.0	200.0
Wheat bran		151.5	51.5
Soybean meal, 44% CP		150.0	50.0
Sunflower meal, 38% CP		40.0	40.0
Molasses cane		20.0	20.0
Calcium carbonate		20.0	20.0
Dicalcium phosphate		5.0	5.0
Sodium chloride		3.5	3.5
Vitamin-Mineral premix[b]		3.0	3.0
Calcium phosphate		2.5	2.5
Yeast		2.0	2.0
Sodium bicarbonate		1.5	1.5
Magnesium carbonate		1.0	1.0
Nutrient composition, g/kg DM			
Dry matter	868.4	882.7	881.9
Crude protein	163.7	164.7	164.6
Ether extract	35.8	29.6	27.2
Ash	34.9	84.5	80.6
Starch	414.6	399.1	396.6
aNDF	184.2	241.5	258.2
ADF	9.4.7	144.1	156.1
Lignin (sa)	20.3	31.8	34.5
NFC[c]	581.4	480.1	470.3
ME, MJ/kg DM[d]	12.35	9.21	9.20

TMR, total mixed ration; aNDF, neutral detergent fiber; ADF, acid detergent fiber.
[a] Wheat middlings obtained from durum wheat (*Triticum durum* Desf. cv. Appulo).
[b] Supplied per kg of diet: vitamin A 13,500 IU; vitamin D_3 2700 IU; vitamin E 13.5 mg; vitamin B_1 8.44 mg; vitamin B_2 5.06 mg; vitamin B_6 2.02 mg; D-pantothenic acid 6.75 mg; vitamin PP 21.9 mg; vitamin B_{12} 0.01 mg; Co 0.51 mg; Fe 67.5 mg; I 1.65 mg; Mn 40.5 mg; Se 0.07 mg; Zn 101.3 mg.
[c] Non-fiber carbohydrates, NFC = 1000 – (aNDF g/kg + Crude protein g/kg + Ether extract g/kg + Ash g/kg).
[d] ME, metabolizable energy estimated from NRC (2007) using feed analysis for each treatment.

with corn-soybean-based diets and no detrimental effects were observed either in production or ruminal fermentation characteristics (Bowman et al., 2004; Shellito et al., 2006). However, to date little research has been conducted to evaluate WM inclusion in pelleted total mixed rations (TMR) for growing or fattening lambs. Hence, this subject should be considered in new investigations. Since WM have the potential to replace the conventional ingredients such as corn in ruminant rations and due to their competitive cost (in overall −50% compared to corn grain), it is worthwhile to study the inclusion of this by-product to provide an alternative feeding strategy for lamb producers. Therefore, the objective of the present study was to search an alternative feeding strategy for lamb producers, by comparing the feeding value of pelleted TMR based on WM to conventional corn-based diets, and to assess its effect on growth performance and carcass traits of lambs.

2. Materials and methods

2.1. Dietary treatments

Two pelleted TMR meeting the nutritional requirements of lambs (NRC, 2007) were formulated to be isocaloric and isonitrogenous. The dietary treatments were: (1) the control diet containing corn as main ingredient (400 g/kg), and (2) the experimental diet containing wheat middlings (WM, 600 g/kg) obtained from durum wheat (*Triticum durum* Desf. cv. Appulo) as main ingredient replacing corn and part of soybean meal and wheat bran (Table 1). Both diets were formulated to contain 165 g/kg CP and 9.21 MJ/kg DM of metabolizable energy (ME) estimated from NRC (2007) using feed analysis for each treatment. Forage in rations (oat hay) was previously chopped by grinding at 25 mm in length, then forages were mixed to concentrate and steam pelleted (8 mm of diameter) to preserve the integrity of the fibrous components, to reduce differences in physical form and to prevent feed selection by animals (Tufarelli et al., 2009).

Authors assure that the studies performed on animals followed the Italian government's guidelines (directive No. 91/629/EEC, received in Italy by D.L. 533/92 and modified by D.L. 331/98).

2.2. Growth trial

A total of forty Comisana breed male lambs weighing 13 ± 0.5 kg (mean ± SEM) at weaning (40 ± 3 days of age) were randomly assigned (20 lambs per treatment) to the control and WM diets. Lambs were housed in individual pens (1.7 × 0.95 m)