

Orange peels as a secondary feedstuff for dairy sheep

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Keywords: orange peels, bioprocessing, by-products, secondary feedstuff, dairy sheep

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In a worldwide context of increasing demand for animal-derived products, welfare trends and climatic risks, sheep farming faces the daily challenge of ensuring its sustainability. More importantly, the dependence of local breeds on imported highly priced feedstuffs, exposed to the speculations of the feed market limits farms' flexibility. Furthermore, forage scarcity due to environmental disturbances modifies rumen fermentation dynamics, leading to suppressed productivity and compromised animal welfare. As an immediate reaction to the above, food by-products arise as alternative feeds, due to their nutritional value and their availability throughout the Mediterranean area. In particular, rich in fiber fruit by-products pose significant interest as alternatives to commercial feeds, in an effort to enhance long-term competitiveness of the sector.

Although more than 17 million tons of food by-products are produced annually during processing alone, just 10 % is used as raw materials for industries such as animal feedstuff production. Orange juice annual world production amounts to approximately 1.53 million metric tons in 2022/2023, according to USDA 2024 report. About 24% of the total world production of oranges is in the Mediterranean countries of Spain, Italy, Greece, Egypt, Turkey, and Morocco. Following juice extraction, a residue comprised of peel (flavedo and albedo), pulp (juice sac residue), rag (membranes and cores), and seeds, remains. These residues are up to 50-60 % of the total fruit weight representing a production of 0.76-0.92 million metric tons of orange by-products and contain high levels of soluble sugars, pectin, proteins, hemicelluloses and cellulose fibers. The use of orange peels as animal feed is advantageous due to their high organic matter digestibility ($\approx 85\%$) alongside their abundant energy availability, particularly in the instances when bioprocessing techniques such as solid-fermentation and hydrolysis have been utilized.

The aim of the present study was to evaluate the use of orange peel from a Greek orange juice industry to produce a high value secondary feedstuff for dairy sheep, within a circular economy approach and assess the effects of this feedstuff on feed consumption, productivity, milk quality and the quality characteristics produced dairy products i.e yoghurt.

Enzymatically hydrolyzed (processed) and unprocessed orange peels were introduced to two treatments of twelve multiparous Chios breed dairy ewes at a rate of 11% DM (groups P & U), while a treatment of 12 ewes served as controls (group C), that were housed in separate floor pens. All ewes were healthy at the onset of the experimentation and were examined by a veterinarian on a weekly basis throughout the trial, which started on the day after weaning until the 16th week of lactation. The rations formulated were isoenergetic and isonitrogenous, by substituting conventional feed ingredients and meeting nutrient requirements, while the animals were individually fed for 84 days, twice a day, after milking. Each ewe received 1,6kg of concentrates, 1,3kg of alfalfa hay and 0,3kg of wheat straw, daily. Feed intake was monitored and feed refusals were collected and weighted daily. Biweekly measurements were conducted to assess milk production and composition, according to ICAR recommendations (ICAR, 2018). Samples were collected during afternoon and subsequent morning milking sessions, followed by their consolidation into a final sample. Each individual milk sample was assayed for fat, protein, lactose and total solids content, using an automatic infrared milk analyzer (MilkoScan™, Foss).

Bulk tank milk was collected at 2 week intervals and used for the production of yoghurt samples (4 batches). Yoghurt samples were analysed for their proximate composition. One way analysis of variance was used to assess differences between treatments using SPSS software (Version 29.0, SPSS Inc., Chicago, IL, USA).

Although fat corrected milk yield was significant higher ($p < 0.05$) between unprocessed and control treatments on Day 14 only, at the majority of the samplings milk fat concentration of the Unprocessed group was significantly higher ($p < 0.05$) than the Controls and milk protein concentration was higher at all samplings for Unprocessed group ($p > 0.05$). All treatments consumed the entirety of the offered concentrates throughout the trial, and over 90% of the offered alfalfa and wheat straw.

The analysis of yogurt's proximate composition revealed that dietary supplementation with orange peels, especially in their unprocessed form, positively influenced the yogurt's composition. This resulted in significantly lower moisture content ($p < 0.01$), higher ash content ($p < 0.05$), increased protein content ($p < 0.01$), and elevated fat content ($p < 0.05$). Carbohydrate content was not affected ($p > 0.05$).

It appears that Processed treatment ewes exhibited higher feed digestibility, while Unprocessed orange peel feed could increase acetic acid production in the rumen, thus increasing fat composition in milk and finally milk fat content. Both processed and unprocessed treatments favorably affected yoghurt composition.

In conclusion, orange peels are a promising secondary feedstuff that can be used as a sustainable alternative ingredient for dairy sheep farming.

Acknowledgement

EU PRIMA Program for Research, Technological Development and Demonstration under grant agreement n°2013 (Turn food industry by-products into secondary feedstuffs via circular-economy schemes-NEWFEED, <https://newfeed-prima.eu/>).

References

ICAR Guidelines: Section 16 Guidelines for Performance Recording in Dairy Sheep and Dairy Goats, February 2018, <https://www.icar.org/Guidelines/16-Dairy-Sheep-and-Goats.pdf>