ACORNS AND CHESTNUTS AS IMPORTANT COMMODITIES IN ORGANIC PIG FARMING

Bělková J., Václavková E., Rozkot M., Kuchařová S.

Institute of Animal Science, Prague Uhrineves, Czech Republic

Abstract

Recent years have seen an increasing trend toward organic pig farming within the Czech Republic and many other countries. One impetus for this development is probably a shifting orientation among consumers from product price to product quality accompanied by growing interest in organic quality meat. Another important factor is the effort to create more humane conditions for farmed animals and to meet welfare requirements. Last but not least, such farming methods are also more environmentally friendly and support transforming agriculture and food systems to sustainability. The essence of organic farming is a return to nature and historic tradition. For pigs, this means pasture farming systems based on collecting such foods as acorns and chestnuts. In some regions, these farming methods have been maintained as ancient traditions and are still used to this day. In many other places, including the Czech Republic, however, these methods represent a return to a forgotten tradition. We have decided to determine the nutritional value of chestnuts and acorns occurring in the local environment. This information is instrumental in optimizing feeding rations for pigs reared through alternative methods as well as evaluating the effects these feeds have on the quality of meat produced.

Key Words: Acorns; chestnuts, pig nutrition, organic farming, nutritional value

Domesticated pigs are bred around the world and comprise one of the most important areas of agricultural production. In addition to highly productive intensive farms, the number of extensive farming operations has recently begun to increase again, which is a welcome alternative for supporters of ecological agriculture and organic production as well as animal rights activists. These farms use pasture systems which mark a return to historical farming practices and more natural lives for pigs that are based on such natural sources as collecting the likes of acorns and chestnuts.

The wild boar (*Sus scrofa*) is a typical omnivore without very rigorous food requirements and which eats grass, tubers, seeds, carrion, roots, rubbish, insects, small vertebrates, and frequently also agricultural crops. While most of its diet (90%) consists of vegetative materials, it always consumes at least one type of energy-rich plant such as acorns, chestnuts, beechnuts, olives, or other crops (depending on its range) (Schley and Roper 2003). For this reason, it primarily prefers to live in mature deciduous or mixed forests. This lifestyle led to historical pig farming that involved pasturing in forests and later on designated pastures. In Central Europe, year-round farming in sties began only with the introduction of improved crop rotation in the mid-19th century (Muzikářová 2011). Extensive farming including pasturing of pigs was partially maintained, and today it is returning in the form of alternative farms due to efforts to protect animals from abuse and maintain biodiversity as well as the economic opportunity associates with increasing demand for meat produced naturally or of organic quality.

Advantages to farming pigs through pasturing are lower costs of entry and improved animal health and welfare. In contrast, negative economic effects ensue from the lower fertility of the breeds used and reduced weight gains due to pastured animals' genotypes, increased thermoregulatory requirements, and greater activity. Within intensive farming, year-round confinement without the possibility to run about and long-term breeding selection has caused pigs to lose their resistance to adverse environmental effects while also diminishing their ability to adapt to unfavorable conditions. Pasture farming, therefore, uses autochthonous breeds, as these are hardier and accustomed to the given environment, and for most such breeds pasture farming has been

maintained as an ancient tradition. Examples of such breeds can be seen in the Iberian pig in Spain, the Alentejano pig in Portugal, the Cinta Senese in Italy, and the Mangalica in Hungary. Such traditions have not been maintained in the Czech Republic, but such breeds as the native Přeštice Black-Pied can be used for these purposes. The Přeštice Black-Pied is very adaptable, undemanding and capable to utilize pasturing.

When pasturing, feedstuffs composition and environmental conditions are substantially reflected in the quality of the meat and fat produced. When acorns are used for feeding or finishing, this meat and fat is used to produce specific products from the aforementioned breeds. The best known of these products is certainly the Spanish ham *jamón ibérico de bellota* from black Iberian pigs (*cerdo negra*) farmed in southern Spain in oak forests known as *dehesas*. During a period of 6 months (each autumn and winter), pigs in this region consume approximately 6.5–9 kg (15–20 pounds) of acorns (*bellotas*) per day with weight gains of up to 0.9 kg/day (Mast Tree Network 2009). Pigs are similarly pastured in the New Forest region of southern England, where the practice is known as "pannage" and pigs feed mainly on acorns and beechnuts for at least 60 days from the start of autumn. During pasturing, chestnuts are often used for fattening, as along with oaks chestnut trees are the most common tree species in the pasture areas. In Spanish *dehesa* regions, the most common oaks are *Quercus ilex* (evergreen oak) and *Quercus suber* (cork oak). In the Czech Republic, the most common oaks are *Quercus robur* (English oak), *Quercus petraea* (sessile oak), and *Quercus rubra* (northern red oak), and the most common chestnuts are *Castanea sativa* (sweet chestnut) and *Aesculus hippocastanum* (horse-chestnut, which is not technically a true chestnut).

Today, fattening on pastures generally is utilized most frequently on the Iberian Peninsula and in the Mediterranean region. A feature common to these systems is the use of local genotypes of mostly high-fat pigs fattened until they have reached a relatively advanced age (14–18 months) and high slaughter body weight of 120–140 kg. At slaughter, they have a high percentage of body fat and a considerable level of intramuscular fat (Nunes 2007).

As noted above, pasture fattening affects the quality of meat and fat produced due to the feed composition. The meat's physical and organoleptic properties change and its composition are influenced substantially in terms of fatty acids. Pigs fed with chestnuts and acorns produce fat and meat with significantly different fatty acids, in particular with increased oleic acid, which further affects sensory properties (Pugliese et al., 2008). At the same time, technical properties also change in the same manner such that the meat and fat is suitable for traditional long-term curing and drying. Nutritional properties also differ, of course, inasmuch as the proportion of fatty acids changes to become advantageous for human nutrition from a cardiovascular perspective (Fallola et al., 1998). Pugliese et al. (2009) reported that Cinta Senese boars fed with chestnuts and acorns had increased monounsaturated fatty acid content in fat in comparison to animals fed with a common commercial concentrate (chestnuts 46.9%, acorns 47.76%, concentrate 44.78%), primarily due to increased oleic acid levels (chestnuts 44.2%, acorns 44.91%, concentrate 42.05%, $P<0.05$). The group fed with chestnuts also had a higher percentage of PUFA-n3 (1.18%) than did the two remaining groups (1.06% and 1.03%, $P<0.05$). Similarly, Petron et al. (2004) found more oleic acid and less stearic and palmitic acids in the meat of Iberian pigs fed with acorns. Although the resulting product has higher fat content than does that of commonly reared pigs, it is healthier for consumers due to its high content of beneficial omega-3 fatty acids and oleic acid, which, among other effects, positively influence cholesterol levels. These pigs are therefore sometimes referred to as "olive trees on four hooves" for their positive health effects which are similar to those of olive oil.

Although the tradition of pasturing was not preserved in the Czech Republic as it was in southern European countries, approximately 50 years ago pasturing was commonplace. This is reflected in nutrient value tables for feedstuffs from 1965 (Čvančara 1965), which in addition to grasses and tree leaves also included beechnuts, chestnuts, and acorns as common feedstuffs. In the following decades, agriculture in the Czech Republic was intensified and so pasturing pigs became less common and farming systems and feedstuffs gradually changed. Information on

alternative feeds also disappeared from the literature due to efforts to unify agricultural production. Although we are now returning to older traditions, we do not have sufficient information properly to introduce them. Today's farmers lack experience with alternative pig farming as well as guidelines and expert information on feeds, including their use and nutritional values. For this reason, we have decided to update this information and determine the nutritional value of horse-chestnuts and acorns commonly occurring in the Czech landscape and evaluate the effects these feeds have on the quality of meat produced.

Material and Methods

We used fallen horse-chestnuts (*Aesculus hippocastanum*) and acorns from English oaks (*Quercus robur*) and northern red oaks (*Quercus rubra*) from 3 different stands respectively. Dried, unpeeled nuts were analyzed according to standard methodology. Dry mass was determined gravimetrically after drying for 4 h at 105°C. Nitrogen was determined after converting nitrogen compounds to ammonium sulfate through mineralization with sulfuric acid and distilling ammonia through alkalimetric titration. Nitrogen substances were then determined by multiplying the amount of nitrogen by 6.25. Fat was determined using dichloromethane extraction with the extracted fat determined gravimetrically. Ash was determined gravimetrically as the residue after the complete burning of organic matter at 550°C. Fiber was determined as the solid residue after acid and alkaline hydrolysis using sulfuric acid and potassium hydroxide after deducting ash gravimetrically. Starch was determined polarimetrically after hydrolysis using a 1.125% solution of hydrochloric acid. Sucrose content was determined by extracting water and then clarifying the water extract with Carrez reagents, and carbohydrate content before and after inversion with 0.1M HCl was determined in an aliquot of the solution using the Luff–Schoorl method. Fatty acid composition was determined after chloroform-methanol extraction of total lipids and alkaline trans-methylation of fatty acids. Gas chromatography of methyl esters was carried out using a Hewlett Packard 5890 Series II chromatograph, evaluation according to standard FAME Mix (37 Component) Supelco.

Results and Discussion

The results of the analysis are presented in Table 1. Considering their high starch content (47.72%), horse-chestnuts can be classified as a high-carbohydrate feed, which is also in accordance with their high sucrose content (12.65%). However, horse-chestnuts also had relatively high content of nitrogen substances (6.58%) in comparison to acorns. Acorns also had starch as a dominant component, and so these, too, constitute a high-carbohydrate feed, albeit with substantially greater fiber content. These values were compared with data found in the literature (i.e., with the nutrient value tables for feedstuffs from Čvančara 1965), which are presented in Table 2. In addition to the feedstuffs' basic nutrient contents, this source also provides us the previously used starch equivalent and oat unit values as well as the ratio of digestible protein to starch equivalent. When comparing older values with those newly determined (Tables 1 and 2), generally only small differences are recorded for horse-chestnuts, with only fat content showing a substantial difference. The value we determined was lower by 1.48 percentage points (after conversion to 100% of dry matter). For English oak acorns, nitrogen content values are almost identical, but there are more substantial differences in fat and fiber content, where our analysis recorded higher values in comparison to the nutritional table values. The question is whether these differences were caused by a change in this nut's nutrient contents over the years or by a specific quality of the nuts. The composition and nutritional values of acorns and chestnuts were also provided in Nehring's Lehrbuch der Tierernährung und Futtermittelkunde (1952). For dried acorns, it provides the following values: dry matter 81.5%, protein 7.5%, fat 4%, fiber 9%, nitrogen-free extract 59%, and ash 2%. This gives an especially different value for protein content that is substantially higher than the value we determined as well as the value stated in the historical nutritional value tables (Čvančara 1965). Nehring's book also provided instructions for feeding acorns to pigs: 1–2 kg of fresh acorns or 0.5–1 kg of dried acorns, preferably peeled (Nehring 1952). To decrease bitterness and thereby improve the palatability for the animals, he recommended reducing tannin content by soaking the acorns in water. For unpeeled, dried

horse-chestnuts, the book provides the following values: dry matter 90.6%, protein 7.8%, fat 6.1%, fiber 6.0%, nitrogen-free extract 68.4%, and ash 2.3%. No other information was found, particularly in the newer literature, apparently because of the disappearance of horse-chestnuts and acorns from the diet of pigs in recent decades. The differences between the values we obtained for English oak acorns and northern red oak acorns are also noteworthy, and in particular the substantially higher fat content of northern red oak acorns. From this perspective, it would be interesting to determine the specific composition of the fat and its influence on the quality of pigs' meat and fat. We have therefore determined fatty acid contents of all nuts. A total of 35 fatty acids were determined, there are some of the more significant saturated FA, the most important representatives of unsaturated fatty acids and the aggregate value of the SFA, MUFA, PUFA in Table 3. If we compare the average values of chestnuts and acorns, we find a higher content of SFA and PUFA in acorns, while chestnuts have higher MUFA. Significant differences are found between English oak acorns and northern red oak acorns. There were found the lowest value of SFA and the highest value of PUFA from all examined samples in red oak acorns. A higher proportion of unsaturated fatty acids, oleic and linoleic should positively affect the composition of pigs' meat and fat and thus human health as reported Fallola et al. (1998), Petron et al. (2004) and Pugliese et al. (2009).

Table 1. *Average nutrient values for horse-chestnuts and acorns determined by analysis*

Feed	Nutrient content in %							
	Dry matter for analysis	**Dry matter in original weight**	**Nitrogen**	**Fat**	**Fiber**	**Starch**	**Sucrose**	**Ash**
Horse-chestnuts	91.28	60.86	6.58	5.22	6.75	47.72	12.65	2.64
Acorns (English oak)	89.24	52.01	3.97	4.33	11.09	46.37	0.08	2.35
Acorns (Northern red oak)	90.39	57.17	4.55	10.43	19.94	25.81	1.20	2.00

Table 2. *Feedstuffs' organic nutrient content in original weight and feeding values (adapted from Čvančara 1965)*

Feed	Gross nutrients in %							
	Dry matter	**Nitrogen**	**Fat**	**Fiber**	**NFE[1]**	**Ash**	**Protein**	**NPN[2]**
Fresh unpeeled chestnuts	64.9	5.50	4.66	5.97	47.17	1.60	4.38	1.12
Fresh peeled chestnuts	63.8	5.00	4.76	5.44	46.94	1.66	4.38	0.62
Dried unpeeled chestnuts	93.6	7.44	6.74	7.65	69.49	2.28	6.31	1.13
Dried peeled chestnuts	93.6	7.56	7.82	6.29	69.42	2.51	6.31	1.25
Fresh unpeeled acorns	50.0	-	-	-	-	-	-	-
Dried acorns	88.3	3.95	3.22	8.68	68.45	1.00	2.96	0.99

[1] NFE, nitrogen-free extract
[2] NPN, non-protein nitrogen

Table 3. *The summary results of the analysis of fatty acids in acorns and horse-chestnuts (rel.%)*

Fatty acids		English oak	Northern red oak	Horse- chestnuts
Myristic	C14:0	0.31	0.16	0.30
Palmitic	C16:0	17.12	12.00	10.88
Stearic	C18:0	4.13	2.73	4.19
Oleic	C18:1n9	35.82	41.02	42.67
Linoleic	C18:2n6	29.27	35.15	24.95
alfa-Linolenic	C18:3n3	2.92	1.75	2.21
Arachidonic	C20:4n6	0.23	0.08	0.16
SFA		25.31	17.42	19.85
MUFA		39.68	43.11	49.34
PUFA		34.98	39.45	30.80

SFA—saturated fatty acids
MUFA—monounsaturated fatty acids
PUFA—polyunsaturated fatty acids

Conclusion

Acorns have not always been just feed for pigs, however. For many generations of our predecessors since antiquity, acorns constituted a common and very important dietary component. Acorns were appreciated particularly in times of scarcity, when they helped keep people healthy and alive during harsh conditions. For humans, acorns represent a good source of carbohydrates, proteins, and fats, and they also contain substantial amounts of fiber and B vitamins. In his book The Earth Care Manual, British permaculture expert Patrick Whitefield even presented the possibility of transforming agriculture from cereal crops toward nut trees, such as walnut, hazel, oak, and chestnut (Whitefield 2011). Such trees might supposedly replace annual field crops as the main source of human food, which would be revolutionary not only in agriculture but also for the landscape. It is clear that acorns and chestnuts have not lost their importance, and we can probably expect their significance to grow in the future. These are very important trees – if not for human nutrition then certainly for organic pig farming.

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Corresponding Address:
Ing. Jaroslava Bělková, Ph.D.
Institute of Animal Science, Prague
Department of Pig Breeding
Komenskeho 1239, 51741 Kostelec nad Orlicí, Czech Republic
E-mail: belkova.jaroslava@vuzv.cz

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