

Experiences of using the fruit waste of the modern Hungarian pálinka fermentation technology for the foraging of extensively kept grey cattle

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Abstract. In this article, the authors report on the experiences of six years of foraging, describing how the fruit wastes generated in the Pannonthalmi Pálinkárium are utilized for foraging Hungarian grey cattle. The goal is not the control or improvement of the cattle's growth indices but the problem-free, continuous and eco-friendly disposal of the fruit waste. They have found that the fruit waste or pomace is virtually nothing else than protein-enriched sugar-free fruit, and that during the utilization of this they have to maximally adapt to the cattle's life-cycle, biological nature and environmental factors, and they will repay you by eating the pomace. They conclude that the grey cattle are a skin-and-hairs-covered bioreactor, which provides an economical service for the distillery through the utilization of the fruit waste. Nowadays, 150,000-200,000 tons of fruit waste is produced every year, and only a few percent of this is utilized in ruminant forage. By writing this article, the authors would like to expand our very scarce knowledge on this topic.

Keywords and phrases: fruit wastes, Hungarian pálinka, Hungarian grey cattle.

1 Introduction

Formerly, the presence of a rural distillery could always be determined by the distinctive odour surrounding it. There was always the odour of the residue gathering in the distillation waste container. These had a storage capacity from 20 up to 100 cubic meters. It was only emptied once or twice per season. The fruit waste has gone through a strong parching phase, when its initial dry matter content of 6-8% increased to 12-16%. This was characterized by acid fermentation, decomposition of carbohydrates and protein putrefaction processes, as well as by high nitrogen losses. (The mineral and micronutrient content remain unchanged.) Its nutritional values and organoleptic properties were heavily damaged and its value as forage decreased. However, there are written records from Pannonhalma and its surroundings, dating back to 1800–1825, about using fresh pomace as forage (Benedictine Abbey of Pannonhalma, Archives, Economic archives. 1800–1825). Positive feeding experiences in subsequent times are not available.

In the last decade (2002–2013), the raw materials, the technology and the quality of the end-products of Hungarian Pálinka manufacturing changed drastically. Hungarian Pálinkas (fruit distillate) with fruity flavour and fragrance came to the fore. The quality, nature and composition of the fruit waste and pomace, which are the by-products of the production process, also changed significantly. Nowadays, the disposal or utilization of the generated wastes is a key issue of Hungarian Pálinka distillation. The following practical possibilities open up for the utilization of these by-products: soil strengthening, composting, disposal at wastewater treatment plants, bio-gas production and foraging.

In 2007, after the change of ownership and modernization, the commercial distillation of Hungarian Pálinka has begun again. During and after the remodification and restart of manufacturing, the owners considered the environment-friendly operation of the distillery as a key element. One of the cornerstones of this was the environment-friendly use of the fruit waste. The history of the distillery can be traced back to 1818 (Benedictine Abbey of Pannonhalma, Archives, Contract, 1818). Written records were found from 1833 and 1845 (Benedictine Abbey of Pannonhalma, Archives, Economic archives. 1825–1835), and, according to these, pomace and fruit waste were “used to feed the cattle by the hostelry and butchery of Tényő”. In the winter, primarily pomace was used to feed the beef cows. This also contributed to the decision to utilize the by-product for feeding the grey cattle.

In the fruit waste area, significant changes have occurred in the past 10 years. In the past, Hungarian Pálinka has been produced from only a few plant species, but nowadays the following types can also be used for foraging: apple-, pear-, plum-, peach, mixed-, pomace wastes, and other minor types in smaller quantities.

With the development of the spirits industry, to meet the consumer needs, more and more types of plants were used to produce Hungarian Pálinka, and, obviously, the fruit wastes of these were also created. Instead of the previous 5-6 types of fruit, now there are about 30 species which we prepare distillate from. Mashers of elder-berry, black-currant, sloe, hip, holly, hawthorn, strawberries, raspberries etc. have appeared. Today, an average distillery can easily produce 15 types of distillates.

2 Material and method

The Hungarian grey herd

The distillery entered into an agreement with the owners of the herd consisting of about 100 grey cattle, held on the slopes of the hills of Pannonhalma, to utilize the fruit waste for foraging. The herd consists of one bull, which is replaced every 3 years, 30-35 mature cows, and 65-70 young calves, which are 1-2 years old.

The feeding of the herd during the grazing period included the pomace as an addition, and even outside this period, from October till April, they were given the pomace besides the hay and corn stalk as main forage. The feeding occurred from 300-400-litre troughs, of which there were 5-6 pieces placed in the pens or on the pastures. Taking into account the seasonality of the Hungarian Pálinka distillation, the pomace can be utilized mainly in the winter season.

Production of fruit wastes

In the case of rapidly utilized fruit wastes, the temperature of the fruit waste is initially 92-95 C°. The heat amount is nowadays utilized in preheating the next cooking batch with heat exchangers. The fresh fruit waste CFU count is extremely low, but even so you have to try to use it up within 48 hours to avoid spoilage processes; the flavours are also better preserved this way. During the winter period, especially in harsh cold outdoor environments, the using of 30-40 C° warm forage is extremely beneficial, especially with calves

and juveniles. Effectively, it is an additional energy input method. The fresh fruit waste has a more pleasant aroma of fresh fruit; so, it is more willingly consumed by the cattle.

During the fermentation, partially pectinolytic enzymes and partially aroma-amplifier enzymes (e.g. beta-glucosidase) are used to open up cell walls and release the fruit esters. It enhances not only the Hungarian Pálinka's flavour but also that of the fruit waste. It contributes a lot to the fact that the grey cattle consume this type of fruit waste with great appetite. Fruit wastes today are much tastier than before due to the use of these enzymes.

One of the cornerstones of the controlled fermentation is that the fermentation is not left to the natural yeasts spontaneously, but consciously selected yeast strains are used, which are adequate for our purpose; and the fermentation is immediate in lieu of the aerobic growth phase. The target CFU is reached by adding the required amount of yeast, not by growing. The yeast concentration shows 10^6 - 10^8 CFU. This cell mass is constantly increasing during the fermentation, and, especially in relation to the fruit, the protein content of the slop also increases. In fact, a major cellular protein production takes place during fermentation. When inducing alcoholic fermentation, and on the 3rd-5th days of the fermentation, we have to add feeding salt to the mash. This is a yeast autolysate supplemented with macro- and microelements. At the end of fermentation, this remains in the slop ingrained in the yeast cells, increasing its value by minerals and proteins.

During the controlled fermentation, pH is kept between 3.0 and 3.5 to avoid infections. Fruit production is around 5.5 pH. The pH required for fermentation can be set with a mixture of lactic and phosphoric acids (90+10%), and then repeated once in the course of the fermentation. The use of other organic or mineral acids is no longer applicable. The yeast incorporates some of the phosphoric acid in its living cells, so pH is constantly increasing. Fresh fruit waste has a pH of approximately 4.2-4.5. This is a very stable value and it has great significance in terms of the rumen flora, while using it as fodder. The acidic pH of the fruit waste during distillation allows even larger molecules to hydrolyse.

Consistency of fruit wastes

Fundamental changes have taken place in this area in recent times, which have significantly increased the foraging value of the fruit wastes. One feature of the former fruit wastes was that fruits had only undergone severe mechanical shredding; so, the waste often contained large pieces of fruit and, in most

cases, parts of cores and seeds in the mash. The homogenization of the mash did not happen either.

In modern fruit processing mill, the cracking grinder, stemmer and crusher machines practically form a uniform quality mash. The seeds of the hard-shell fruits are completely removed from the pulp and are separately, fully utilized mainly for energy production, partly as forage for wild animals. Only the grape and black-currant wastes can contain seeds.

Added pectin enzyme (1-2 g per 100 kg of fruit) during the processing of the mash increases homogenization (virtually, a biochemical homogenization). The moving of the liquid-like mash is easy and simple with pumps.

3 Results

Results of our studies on the composition of fruit wastes

Comparing today's knowledge about the fruit texture of the mash with earlier ones, the following observations can be made: The dry matter content nowadays is lower than before. This is due to the fact that a while ago mash was parched in pits, where often half of the moisture content evaporated or drained. Nowadays, this is unimaginable. In the past, mash solids content was 12-15%, whereas today it is between 6% and 9% (wild fruits have higher values). The fibre content and the flesh pieces of the mash are highly homogenized. Despite this, the mash begins to get layered after 48 hours of storage. Typically, the fibres and flesh pieces settle at the bottom of the tank, except for the quince and apple, where the solid phase floats on the top of the slop and often forms a one metre thick cap. Knowing this difference, you can save yourself a lot of trouble during the treatment of the mash. Hence, the seeds cannot be found anymore in today's mash: they are unsuitable for feeding pigs. (Formerly, Mangalitsas were fed with this). Now the seeds are mainly used to feed wild boars.

The fruit pulp consistency has a significant impact on the amount of slop as well. A significant amount of water must be added during the processing of many fruits (e.g. quince). There are factors in the Hungarian Pálinka production which reduce the amount of slop. These are: alcohol removed by distillation: 3-10% reduction; carbon dioxide departing during fermentation: 1-3% reduction; seeds and stalks removed during processing: 10-30% reduction.

Technological processes which increase the amount of slop: addition of nutrient salts, acids and yeast: 1-2% volume growth during fermentation; water

added for processing can result in a 30-40% growth. In extreme cases, even a 2-3-fold increase in the amount of slop can be observed (e.g. chestnut).

Loss and gain factors add up to give the final quantity of the slop. The amount of fruit waste generated during the processing of some fruit species is shown in *Table 1*.

Table 1: The amount of fruit waste generated during the processing of some fruit species in the Pannonhalmi Pálinkárium between 2009 and 2013

Fruit species (100 kg)	Quantity of waste (kg)
Apple	90-92
Pear	90-92
Rasp- / Strawberry	95-98
Plum	75-80
Peach	77-82
Grape	85
Pomace	95-110
Blackthorn, Hawthorn	90-110
Quince	110-130
Chestnut	200-250

Nutritional values of fruit wastes

Perhaps the most significant change has taken place in this field because of the development of fermentation and distillation technologies. Under fruit waste (f.w.) nutritional values, not only the chemical parameters can be examined but also the classic organoleptic properties. The cattle's willingness to consume fruit wastes is greatly affected by this. A few new technological steps may significantly affect the nutritional values of the wastes.

Below, we present five fruit waste feed sample test results in *tables 2* and *3*, which show that the Williams pear represents well the waste of apple-like fruits; 40% added water was used when processing the quince, the elderberry waste has one of the highest dry matter contents, peach represents the cultivated stone fruit type and sloe represents the wild stone fruit type.

Table 2: Nutrient content of 1 kg fruit waste

Parameter (g/kg forage)	Quince	Williams Pear	Elder- berry	Peach	Sloe
Original solids	67	75	172	79	90
Crude protein	4	5	25	10	5
Crude fat	1	1	27	1	1
Crude fibre	11	12	38	10	4
Crude ash	4	7	17	9	9
N-free extract	47	50	65	49	71

Table 3: Specifics of 1 kg fruit waste

Parameter (g/kg forage)	Quince	Williams Pear	Elder- berry	Peach	Sloe
Crude protein	56	66	146	125	56
Crude fat	12	10	158	13	8
Crude fibre	160	161	219	119	43
Crude ash	62	92	99	112	101
N-free extract	710	671	378	631	792

Special content formulas of fruit wastes

Based on our measurements, the alcohol content of the fruit waste did never reach 0.1% by volume during the six years examined. By complying to standard distillation parameters, it may be excluded that the fruit waste contains ethyl alcohol. The presence of higher alcohols and polyhydric alcohols is natural.

Theoretically, the yeasts reduce the fermentable sugars in the mash to below 0.1%. Normally, sugar-like compounds may become 3-4 carbon atom carbohydrates or oligosaccharides. If you encounter fermentation after distillation (so, there is sugar in the mash), that indicates a huge technological error, which can be one of the following: Alcoholic fermentation has stuck, hence sugar remained in the mash. This can happen because of the high alcohol content (e.g. chestnut waste) or because of a too cold environment. The latter one

can occur in late maturing plants (blackthorn). Or, the degradation of starch or oligosaccharides did not happen in some fruits which would have required post-maturation; instead, it happens during or after the distillation. In this case, the fruit waste given as forage may fizz after a few days. Distillers seek the perfect fermentation; so, the presence of residual sugar is very rare.

Fruit wastes can contain hydrogen cyanide, but only when the fruit seeds are in the mash during the alcoholic fermentation and distillation. In case of stoning, this cannot happen. Stoning is the guarantee to avoid the formation of ethyl carbamate as well. However, a not properly configured stoning machine can break the seeds, which can contaminate the slop. This is a real danger when working with early cherry and sour cherry (it has weak cores). Interesting, as it should be mentioned, that according to literature (*Szigeti*, 2010), the non-seeded mash of sloe has the highest content of hydrogen cyanide.

High copper content is a real danger, but it can be easily avoided. Mash with a low pH can dissolve some copper from the walls of the distiller. However, to have a high enough content to be able to measure by quick tests, you have to keep the warm mash in the distiller for more than 50 hours. Observing these three rules, the increased level of copper can be ruled out by following a few simple rules: the mash has to be in the distiller only for the time of the distillation, the distilling equipment, which has not been used for several months, should be always washed with water first, and never spill the pre-distillate into the mash (this is nowadays impossible because of the excise labels).

Experiences of the consumption of fruit wastes by grey cattle

Our first feeding experiences were that the grey cattle liked these various by-products very differently. There are types which we could hardly get the cattle to consume and types which cause real fights among the herd. Based on our experiences, the fruity, juicy, sweet-smelling fruit wastes were the majority; the ones with strong smell or taste of vegetable alkaloids were the less popular. Thus, elder-berry and black-currant definitely belong to the latter category. Experience shows that cattle do not like plant wastes, which they do not consume on the pasture (e.g. elder-berries, rose-hips).

Based on this experience, the popularity and consumability of fruit waste can be classified into three groups, which we have to take into account when developing a feeding strategy. The groups are: most liked and always gladly consumed: strawberries, raspberries, cherries, peaches and pear; consumed after a few days of getting accustomed to: plum, apple, pomace and mixed

mash; hardly ever consumed: elder-berry, black-currant, hawthorn, sloes, rose-hips and quinces.

According to our experiences, the propensity of the grey cattle for the consumption of fruit wastes is also affected by the seasons and the feeding environment. The main points here are: In the early autumn, the herd gets less used to eat fruit waste – because of the shortage of it; so, they have to get used to it again. During the winter period, especially the extremely cold temperature, the propensity for consumption increases. The February calving period and the start of lactation also increase consumption. From the end of April, the availability of fresh pastures drastically reduces the propensity for consumption. The herd is in a “green intoxication”. These foraging experiences determine the order of distilling in order to move the grey cattle in the direction of the largest possible quantity of fruit waste consumed.

The habituation to consume the fruit waste of the autumn season is achieved by the most popular types: raspberries, cherries and strawberries. The consumption begins virtually immediately, and the consumption patterns develop. With winter approaching, the reduction of green fodder makes the moderately popular fruit wastes more and more accepted; so, these are preferred (plum, apple). During the winter, the more difficult types can be given, purely or mixed with other types. Elder-berry can be fed only mixed with other fruits because grey cattle never eat it in pure form. The consumption of the less popular types can also be improved by reducing the quantity of drinking water.

When the pastures become green, the propensity to consume fruit waste is greatly reduced; in this case, the feeding with peach and pear wastes is effective. Not only the plant species affect the edibility of a certain type of fruit waste but, in many cases, fruit varieties within the species as well. As an example, among pears, the type of “helmet of Bosk” is far less popular than the Williams pear, or “Oliver Irsai” is more popular than any red grape waste. The explanation of the differences is in fruit succulence and flavour.

Eating sequence, quantities eaten

Grey cattle can be accustomed to good quality fruit waste in only 3-4 days, even if they never have eaten something like this before. In a mixed herd structure, we can count about 25-35 kg/head consumption/day. Standard deviation is depending on the size of the cattle and can be anywhere between 1 and 40 kg. Among the categorized types of grey cattle (primitive, yoke, dairy, manorial), the primitive consumes the least and the dairy the most. The Hungarian grey cattle is not a homogeneous breed, several types have

developed:

- Primitive, small type: Undeveloped, low-shoulder-height model. It features an unattractive horn evolution and a faulty foot structure.
- Rough yoke type: Large shoulder height, deep-chested. The legs are long, their movements are lively.
- Fine dairy type: Sleek, small, precious, delicate constitution grey type cattle. Thin horns, udders more advanced.
- Large-scale type: Noble, good-looking, often exceptionally beautiful horns; the most common type today.

In case of changing the type of the fruit waste, the change-over in 2-3 days, with mixed dosages, is problem-free. Changing to a more popular type (peach) is immediate, changing to a less popular one (black-currant) takes more days. We have never experienced any problems in life functions or digestive functions during change-overs. We had no cases of any diseases either. These are personal experiences.

The eating sequence is based on the rank in the herd. The sequence is: bull, old cow, young cow and calf. The heads in the top of the ranks are usually guarding the more popular types of fruit wastes (peach, raspberry and strawberry); they do not let others near them. In the case of extremely popular types (Irsai pomace), we also have to be aware of occasional overconsumption. The best method to resolve the problems posed by the eating sequence is to create more feeding points. One feeding point can accommodate 10-20 heads. The young calves begin to eat the slop after 1 month of age. According to our observations, the calves like the warm fruit waste best in the February-March period.

After that, the massive appearance of pasture grass causes a temporary reduction in the fruit waste consumption. This is the main concern to pay attention to because fruit waste consumption can completely cease in a few days and the quality of the waste degrades over time; so, the cattle will likely eat it even less near the fresh pasture. We can say that this time is the most critical period of the foraging with fruit wastes. However, with several small tricks, we can overcome this problem.

Economic implications of fruit waste consumption

Strive to place the distillery as close to the forage production site as possible: the best is in a 5-km radius from the herd. Transportation is not economi-

cal due to the low nutrient content and high water content. In spite of the pasturage, the logistics of the continuously generated fresh fruit waste is to be resolved. The distillery's production quantity should follow the size of the herd, never vice versa. Based on the low performance data of the grey cattle, under extensive keeping, the fruit waste becomes a main feed. For grey cattle, 30-40% of the nutrient needs can be covered by it. Vitamin B content of this forage is significant, but this is still not really taken advantage of (Hegóczki, 1997).

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