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Spelt Glumes as Standard Fuel

The project for a master´s thesis was to determine how meaningful and legally possible it would be to use spelt glumes pressed to pellets for thermal utilization in small heating facilities with a heating capacity ranging from 15 to 100 kW. The current disposal costs of spelt glumes, borne by the processing industry, would thereby be eliminated. By thermally utilizing spelt glume pellets, a low-cost and CO_2-neutral fuel could be provided at a decentralized level.

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Keywords

Spelt, glumes, pellets

During the processing of glumed spelt, approximately 36,000 to 55,000 tonnes of spelt glumes were obtained in Germany in the harvest year 2006. Due to their low specific weight, these spelt glumes have high storage space requirements because no other value-adding possibilities of utilization are available [1].

One potential kind of utilization is the production of spelt glume pellets. These can be used thermally, e.g. in a small furnace having a rated heating capacity of 15 to 100 kWh. According to section 3, paragraph 1, number 8 of the 1st Federal Immission Protection Directive, straw and other plant materials are approved as standard fuel. These materials may be burnt in the above-mentioned facilities.

In order to be able to classify spelt glumes as a straw-like substance and thus to utilize them as standard fuel, the botanical classification and fuel characteristics were investigated in this study [2, 3].

Spelt Glume Pellets

The spelt glumes from the harvest year 2005 examined in this study, which came from ecological farming, were supplied by the mill in Bohlsen. This mill processes approximately 3,000 t of spelt per year. During this process, about 700 t of glumes are obtained. In the so-called husking mill, the glumes were separated from the kernels and comminuted by a hammer mill down to a size of < 5 mm In a pelleting facility, five glume samples were pressed to pellets having a diameter of 4.5 mm.

Botanical Classification of the Spelt Glumes

After kernel removal, the dry leaves and stems of crops and cereals in particular are termed straw [4]. The inflorescence of spelt consists of little ears with several bracts (glumes). At the bottom, the flower is surrounded by two glumes. Then, the two-rowed floral glumes serve as subtending leaves for the individual flowers. They are followed by bicarinate paleae, which are also termed prophylls. After the kernel has formed, the floral glume and the palea firmly enclose the kernel and thus provide a protective function [2, 3].

If one compares the definition of straw given above with the botanical classification of glumes, spelt glumes after husking must be considered dry cereal leaves from which the kernel has been removed.

Fuel Characteristics of Spelt Glumes

In order to verify botanical classification, the fuel characteristics of the spelt glume pellets were determined and compared with those of straw and straw pellets. The determination of the fuel characteristics also pro-

Table 1: Fuel characteristics of spelt glumes compared to solid biomass fuels [acc. to 5, 6]

Fuel	Water content %	Ash content %	Calorific value MJ/kg	Calorific value kWh/kg
SGL 105¹)	8.69	8.22	16.2	4.51
SGL 108¹)	8.49	9.55	15.9	4.42
SGL 111¹)	7.61	7.92	16.2	4.52
SGL 121¹)	8.15	8.6	16.0	4.46
SGL 139¹)	8.48	5.86	16.7	4.65
Mean value¹)	8.28	8.03	16.2	4.51
Rye straw²)	-	4.8	17.4	4.83
Wheat straw²)	-	5.7	17.2	4.78
Straw pellets³)	8.00	6.8	19.4	5.39
Wheat kernels	-	2.7	17.0	4.72

¹) SGL. Spelt glume pellets were pressed without additives
²) Straw in natural condition
³) Straw pellets were pressed without additives

Table 2: Element contents of spelt glumes as compared with solid biomass fuels [acc. to 6, 7]

Fuel	C %	N %	Cl %	S %	K %	Ca %	Mg %
SGL 105[1])	46	0.567	0.10	0.09	0.223	0.076	0.034
SGL 108[1])	46.79	0.468	0.09	0.09	0.218	0.068	0.032
SGL 111[1])	46.3	0.506	0.03	0.09	0.202	0.070	0.033
SGL 121[1])	45.97	0.473	0.02	0.09	0.236	0.090	0.039
SGL 139[1])	47.04	0.415	0.10	0.09	0.136	0.064	0.030
Mean value[1])	46.42	0.485	0.068	0.09	0.203	0.073	0.033
Rye straw[2])	46.6	0.55	0.40	0.085	1.68	0.36	0.06
Wheat straw[2])	45.6	0.48	0.19	0.082	1.01	0.31	0.10
Straw pellets[3])	-	0.89	0.02	0.2	1.28	0.24	0.06
Wheat kernels	43.6	2.28	0.04	0.12	0.46	0.05	0.13

[1]) SGL. Spelt glume pellets were pressed without additives
[2]) Straw in natural condition
[3]) Straw pellets were pressed without additives

vides a meaningful comparison with other pellet furnace fuels common on the market.

The calorific value as well as the water- and ash content of the spelt glumes are listed in *Table 1*. At 8.28%, the average water content of all five samples is at a level common for pellets. The ash content of 8 % corresponds to the ash content of straw pellets. At 4.51 kWh/kg, the average calorific value is at the level of cereal kernels and 0.88 kWh/kg below the calorific value of straw pellets. Thus, 2 to 2.5 kg of spelt glumes can replace approximately one liter of heating oil.

The results of the chemical element analysis in *Table 2* show that the carbon content of 46.4 % corresponds exactly to the average of the other fuels. Therefore, one can expect that spelt glumes allow the carbon monoxide limit of 4,000 mg/m^3 to be observed like other fuels. At 0.48 %, the average N-value was 50 % lower as compared with straw pellets, which will result in a similar reduction of the nitrous oxide emissions during combustion.

Since hydrogen chloride emissions increase with the chlorine content of the fuel, chlorine values in the fuel should be as low as possible in order to keep the resulting corrosion of the furnace to a minimum. Given an average chlorine content of 0.068 %, the values determined for spelt glume pellets were not critical. It should be examined whether the low chlorine contents of glume pellets as compared with wheat- and rye straw are an agronomical or a botanical characteristic or caused by processing.

Given the low values of the analysis, noticeable sulphur dioxide emissions are not expected as in the case of the other biogenous solid fuels.

The melting behaviour of ashes in the combustion chamber and, hence, slag formation is mainly dependent on the contents of calcium, potassium, and magnesium. Especially the values of calcium and potassium are many times lower and those of magnesium are almost 50% lower than those of the reference fuels. Other combustion tests will have to show how positive the effects are which this exerts on the avoidance of potential ash slagging in the combustion chamber of furnaces. Due to the low measurement values, however, one can assume that the tendency towards slagging is small.

All other element contents (*Table 3*), such as those of iron, aluminium, sodium, or manganese, are far below those of straw pellets in some cases. The contents of heavy metals, such as manganese, copper, zinc, or cadmium, are also lower. This has positive effects on the later utilization of the grate- or coarse ashes of the furnace as fertilizer.

Conclusions

According to the analyses presented here, the element contents of the examined spelt glumes are at a similar or a better level as compared with straw pellets. However, the results of future combustion tests also significantly depend on the furnace used. If the furnace is specially designed for the utilization of cereal-like solid fuels, very good combustion results may well be expected. Due to the botanical classification of spelt glumes as straw or similar plant material, which is confirmed by element analyses and calorific value measurements, they should be recognized as standard fuel from a scientific viewpoint.

It seems sensible to extend future studies to include other glumed cereals, such as oats or barley, whose processing also leads to large glume quantities as a by-product. The thermal utilization of glume pellets as a by-product of milling provides a decentralized, inexpensive, and CO_2-neutral fuel alternative based on renewable raw materials. Environmentally friendly heat from glume pellets can make a contribution towards sustainable energy supply in Germany.

Table 3: Element contents of spelt glume pellets compared to straw pellets [acc. to 7]

Element content in mg/kg DM	SGL[1]) MW	Straw pellets[2])
Na	48.4	100
Al	37.8	219.4
Mn	19.6	28.3
Fe	92.8	596.8
Cu	1.8	3.1
Zn	13.6	16.3
As	0.158	0.3
Cd	0.03	0.1
Ba	4.8	49.2
Pb	0.42	1.7

[1]) SGL. Spelt glume pellets were pressed without additives
[2]) Straw pellets were pressed without additives

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