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Food grain in large plastic bags – a safe storage

Storage of biomass in large plastic bags is a well established technique in many countries. The impact of changing temperatures on the quality of wheat grains during the anaerobic storage in the bags is controversially discussed. Freshly harvested wheat was stored for six months without additives in the large plastic bags and the quality is compared to that of a conventional storage. The results demonstrated that neither the anaerobic atmosphere in the bags nor the seasonal decreasing temperatures lead to quality differences between the grain varieties. The storage in large plastic bags can be recommended as a favorably alternative to the conventional storage.

Keywords

Wheat, storage, large plastic bags, quality, costs

Abstract

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The range of products that can be stored in large polyethylene bags is fairly substantial. Besides sustainable vegetable products (e.g. grass, maize, whole plant silage, wet and dry grain, sugar beet), and substrates from processing in agro-industries (e.g. pulp for pellets, draff, pomace), organic leftovers may also be considered. Preservation and storage in hermetically sealed large polyethylene bags is well known from silaged goods. Key reasons for this growing trend are low costs, limited risk, and high quality in a gas tight system. In addition to that, the storage in large polyethylene bags under anaerobic conditions facilitates the optional extension of storage periods to react on price changes, without having to invest in buildings. Farmers can deliberately forgo building efforts, choosing a flexible storage system instead, thus being able to adapt to conditions outside their realm of control.

Grain in large polyethylene bags

Normally, grain is stored after harvesting. Particularly grain for food production must be kept dry, dependent on its wet content, and requires ventilation during storage - at least in certain intervals. According to reports [1; 2; 3], grain can be stored in large polyethylene bags up to two months. However, there is only little information provided about the eventual quality of the grain.

Reports about the storage of maize in large polyethylene bags have shown that its quality remained unaffected [2; 3; 4]. Harrel et al. [2] determined a reduction of 2 % in moisture content in maize after storage. Due to the carbon dioxide atmosphere inside the polyethylene bags, neither living insects nor mould was detected during the two-month storage.

At high carbon dioxide contents, Muenzig [5], however, describes declined germination properties of wheat grains with moisture contents of 14 % and a loss in sensory qualities. Wagner et al. [4] report about continuation of microbe activities under anaerobic conditions in higher grain moistures, potentially causing odour changes.

Under the scope of the present research, freshly harvested food grain was stored for six month under typical practice conditions in a hall, and in polyethylene bags. The two different batches were compared with respect to various quality parameters and the storage temperature was tracked.

Storage and measuring

'Tarso' wheat with moisture content of 12.9 % and crops of 87 dt/ha was harvested by Budissa Agrarprodukte Preititz/Kleinbautzen GmbH. The base protein content was 14.8 % in dry matter (DM); the starch content at 67.2 % DM; the falling number 407; the hectolitre weight 79.6; and the sedimentation grade 43. Using a Profi Farm Bagger RB-A, 75 tons of grain were bagged in two large polyethylene bags (AG BAG) (**figure 1**). The diameter of the bags was 2.70 m and the foil material thickness 215 µm. 4 measuring points (seal valves) were fitted in each side of the of bag 1 for later regular sample taking; bag 2 was fitted with 4 measuring points in only one side accordingly. Bag 2 was scheduled to be sampled only after 6 months to prevent the stored goods from potential impact by the sample taking. Bag 1 was furnished with eight data loggers through the measuring points, while bag 2 was furnished with 4 data loggers respectively. Eventually, the bags were covered with bird protection grids and sand bags. A comparator batch of grain

Fig. 1

Fig. 1: Storage in large plastic bags by means of Profi Farm Bagger RB-A

Fig. 2

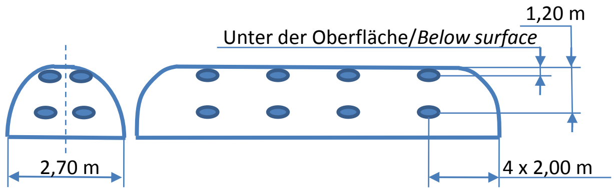

Fig. 2: Sketch of the large plastic bag with measurement points

was stored in a non-ventilated hall. Four data loggers were implemented into this wheat batch.

Sampling and analyses

Both, the comparator batch and the wheat from bag 1 were sampled on storage, after two and four weeks, and again after three and six months. Samples from bag 1 were taken through all eight valves from two different horizons: directly from under the foil surface and from a depth of ca. 1.20 m (**figure 2**). Likewise, eight samples were taken from the comparator batch; four samples right beneath the surface, and four samples at a depth of ca. 0.8 m. The samples were examined regarding the following parameters: dry matter, pH-value, content of starch and base protein, as well as the content of mesophilic bacteria, yeasts, and mould [6]. After six month, additionally, germination behaviour was examined by evaluating germination potential and germination capacity, and bag 2 was sampled and evaluated respectively.

Results

Thermal history. In both large polyethylene bags almost the same thermal history was registered, i.e. a gradual temperature decline and harmonization with the outside temperatures (**figure 3**). These results suggest very low microbiological activity.

Ingredients and micro organisms. A comparison across all mean values of the samples in the different storage variants shows an almost identical development in both chemical as well as microbiological parameters (**figure 4**). Compounds present at the time of storage, e.g. starch and base protein, were evident in nearly unchanged proportion; pH-values also remained unchanged. An increase in the examined groups of micro organisms could not be established. The contents of the examined germ groups were identified to be within the range of preliminary benchmarks of DGHM (German Society for Microbiology) for grain [7].

Germination. After six months of storage, the wheat stored in large polyethylene bags showed almost the same germination characteristics as the grain stored in the hall. The germination capacity of 94 % in the bagged grain was 4 % lower than in the conventionally stored grain; the germination potential was 97 % in both storage variants.

Process costs. The process costs for the storage of 5,000 t/a grain in large polyethylene bags are 2.99 EUR/t; from 20,000 t/a costs decrease to 2.26 EUR/t (**table 1**). Farmers thus are provided with a favourable alternative for flexible storage of grain.

Conclusions

The examination under practice conditions could establish that wheat harvested at storable dry matter content can be stored in large polyethylene bags up to six months without loss in quality. The initial question, whether the grain would lose in quality by storage in large polyethylene bags between summer and winter, can thus clearly be denied. The results indicate that both the content of the examined nutrients as well as the relevant micro organisms only changed marginally during storage. Otherwise, no differences were established in the quality of the samples from the different sample levels and from the different storage variants. Thus it can be concluded that storing wheat in large polyethylene bags is presumed not to affect baking properties in any respect. Further examinations shall be undertaken.

Due to the very low costs of the flexible process, the storage in large polyethylene bags provides an alternative to high investment costs for durable storage constructions for grain. The location for storage can be chosen flexibly to optimize transport ways. With variable bag lengths farmers can adjust the storage capacity to actual batch dimensions and storage durations. Consequently, the grain can be stored to the point of highest potential market value.

Fig. 3

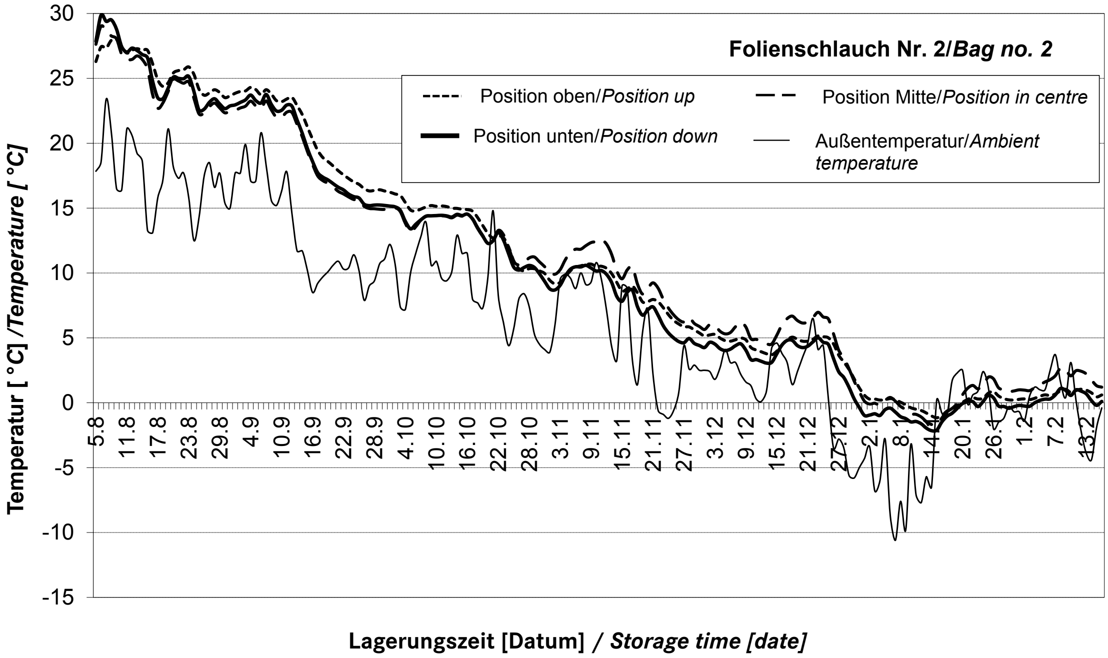

Fig. 3: Temperature curve of different positions in large plastic bag silo no. 2 during storage

Fig. 4

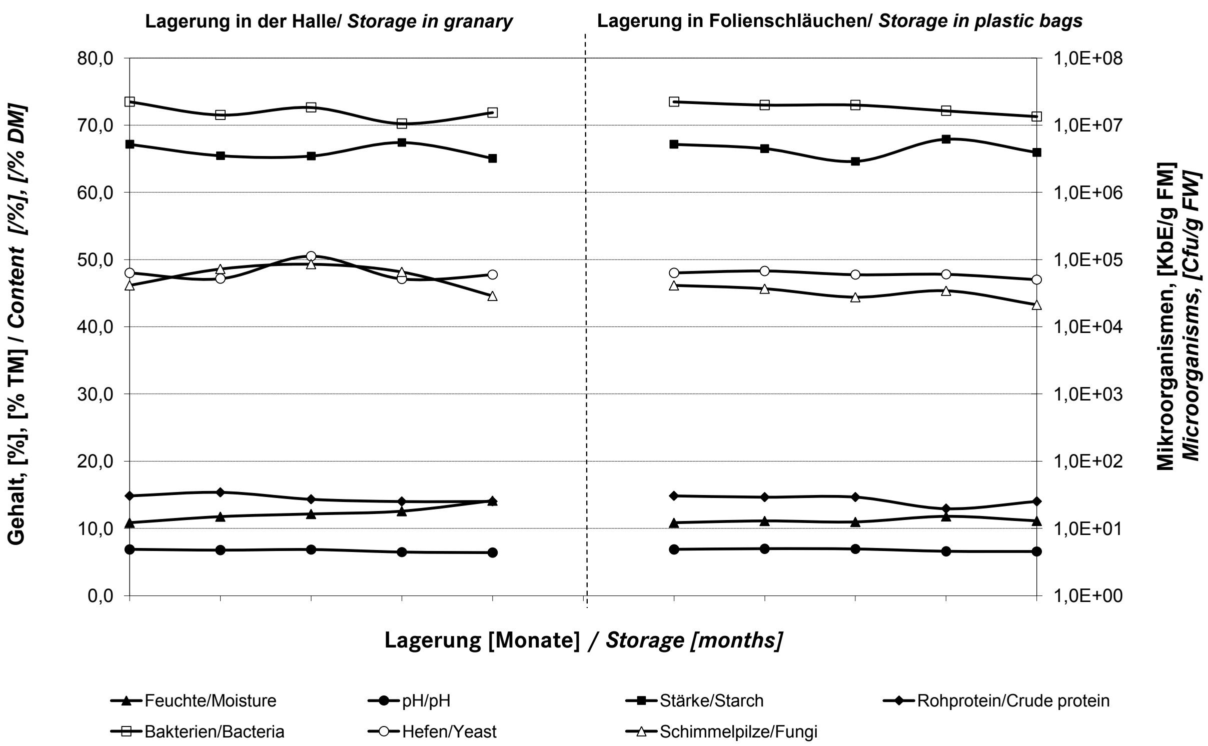

Fig. 4: : Chemical and microbiological data of wheat during a 6-months storage depending on the type of storage

Table 1

Table 1: Process costs for the storage of dry grain in plastic bags

Position/*Position*	**Einheit/*Unit***	**Variante 1/*Variant 1***	**Variante 2/*Variant 2***
Getreidemenge/*Tonnage*	t/a	5 000	20 000
Anschaffungspreis für die Schlauchpresse/*Investment cost*	€	30.000.00	30.000.00
Restwert der Schlauchpresse/*Residual value*	€	10.000.00	5.000.00
Nutzungsdauer/*Usage*	a	6	6
Abschreibungen/*Depreciation*	€/a	3.333.33	4.166.67
Zinsanspruch (6 % Zinssatz)/*Interest*	€/a	1.200.00	1.050.00
Reperaturkosten (0,10 €/t)/*Repair costs*	€/a	500.00	2.000.00
Maschinenkosten Schlauchpresse/*Machine costs*	€/a	5.033.33	7.216.67
	€/t	1.01	0.36
Inhalt Schlauch/*Grain per bag*	t	250	250
Anzahl Schläuche/*Number of bags*	-	20	80
Anschaffungspreis Schlauch mit Mengenrabatt/ *Price per bag with allowance*	€/Schlauch *€/Bag*	445.00	425.00
	€/t	1.78	1.70
Massestrom Befüllung/*Performance of filling*	t/h	360	360
Befülldauer/*Duration of filling*	h/a	13.9	55.6
Lohnkosten (1,5 AK je Presse, 15 €/h)/*Labour costs*	€/a	312.50	1.250.00
	€/t	0.06	0.06
Antriebstraktor (50 €/h)/*Costs of tractor*	€/a	694.44	2.777.78
	€/t	0.14	0.14
Gesamtkosten/Total costs	€/t	2.99	2.26

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