ENSILING – A NEW PRACTICE FOR PRESERVATION OF HEMP

SILOSAVIMAS – NAUJAS KANAPIŲ KONSERVAVIMO METODAS

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The conventional production of natural fibres from hemp is based on field drying and retting of fibre straw. At the usual harvest time in September, weather conditions are often problematical for the processing of harvested hemp. A weather-independent post harvest technique is under investigation at the Leibniz – Institute of Agricultural Engineering.

The harvest of hemp by means of a chopper followed by anaerobic storage is favourable for the farmer because the weather risk can be avoided. Additional steps are the same as for ensiling of fodder. As a further advantage of this novel processing technology, the whole plant material will be processed to final products like insulation materials and fibre boards or semi products for injection moulding. At present, a pilot plant with a processing capacity of 1t per hour hemp silage is built up and tested at the institute.

Hemp, fibre processing, wet preservation.

Introduction

When the ban on cultivating hemp with a THC content of less than 0.3 % was lifted in spring 1996, the path was free for the return of an old culture plant. Bast fibres, especially hemp, naturally have a large variability in their properties, and as valuable raw materials can be used for a large number of applications. Immediately after hemp cultivation was allowed in Germany, hemp was sown on an area of altogether approx. 1,400 ha. In 2005 the area under hemp cultivation was approx. 2,700 ha. That same year the total EU area under hemp cultivation was approx. 16,000 ha.

In Germany hemp is harvested in the month of September. The climate conditions are characterised by decreasing dryness and increasing temperature fluctuations. Traditional processing of hemp in a drying line comparable with hay production is very labour-intensive, and the results depend strongly on weather
conditions. Drying of the harvested material to obtain a dry substance content of at least 85% can only be achieved at the earliest after seven days lying in the field [1]. However, long lying times in the field can lead to quality reductions in the harvested product. The development of a new process aims to reduce the weather risk. In a moist product line, the hemp is mowed with field choppers, chopped and transferred to transport vehicles. The work input is reduced as windrow processing measures and bale production are no longer necessary. To develop the new process it first had to be clarified what cultivation and harvesting conditions are necessary. In addition, it was necessary to check whether additives are needed for preservation, and what varieties are particularly suitable. One of the most important tasks was to search for suitable processing options for the preserved hemp, depending on the fibre properties.

**Literature review**

Now that cultivation is promoted by the EU, hemp and flax fibres have become established as high-grade locally produced raw materials for a variety of innovative products, for example in the building construction and automobile industries [2, 3]. In the year 2002 approx. 24,000 t natural fibres were processed in the European automobile industry (including approx. 17,000 t in Germany and Austria alone), and the current demand for high-grade locally produced fibres cannot be met. On the grounds of the EU Directive on end-of-life vehicle disposal and modern developments for competitive production of compound materials on a natural fibre basis, current forecasts predict an increase in the demand for natural fibres to approx. 70,000 t per year 1 for the automobile branch alone within the next few years [4]. These growth markets require high quality fibres of guaranteed constant quality [5]. Such fibres can only be produced locally in close cooperation between agriculture and fibre processing with cross-sectoral quality management. Core issues of fibre plant cultivation [6, 7, 8], retting [9, 10] and suitable harvesting methods [11, 12, 13, 14, 15] have been solved satisfactorily during the past few years. At present the greatest shortfalls lie in fibre processing and quality management. Approx. 55% of total fibre processing costs are generated in the conventional processing methods used industrially in Germany, e.g. in plants constructed by the manufacturers Bahmer, Laroche, Temafa and Demaitere [16, 17, 18]. Despite the high investments of over € 2 million, these plants do not operate free of faults and the planned mass throughput rates cannot be realised. The gradual reduction of EU subsidies for fibre plant cultivation and fibre processing down to the level of grain support confronts the processing facility operators with additional challenges. There is only little leeway in the price for fibre straw and the selling price for fibres and hurds. It is important to pay farmers an attractive price for the fibre straw in order to secure the raw material supply needed by the processing plants. On the other hand, the selling price attainable for final products is limited in view of the competition with products already established on the market [3].
Practical experience obtained during recent years in hemp and flax fibre processing has shown that new solutions to existing process engineering problems are needed to produce high-grade technical fibres for industrial applications [19, 20].

In the long term a reliable value-adding chain from cultivation, through fibre processing, up to the manufacturing industry will only develop if the current process engineering problems in the fibre processing plants can be solved satisfactorily.

**Objects and methods**

Between 1997 and 2005 the different influences on the fibre properties of chopped hemp in anaerobic storage were investigated each year (Figure 1).

<table>
<thead>
<tr>
<th>Cultivation</th>
<th>Hemp varieties with THC contents &lt; 0.3 %: Beniko, Bialobrzeskie, Fasamo, Fedora 17, 19, Fedrina 74, Felina 32, 34, Gluchowskaja 33, Juso 14, Juso 31, Kompolti Hybrid TC, Kompolti, Uniko B F 2, Lovrin 110, Solotonoschskaja, Juso 11</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Areas cultivated</strong>: 0.25 ha to 5 ha</td>
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<tr>
<th>Harvesting</th>
<th>Mounted field chopper Champion 1200 from Messrs. Kemper Fortschritt field chopper E 281 C, field chopper John Deere 6810 Maral 150 from Messrs. Landtechnik Schönebeck</th>
</tr>
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<tr>
<th>Storage intake / Compaction</th>
<th>Additives: 1/ 2 % lactic acid, 1,5/ 3 % caustic soda, 1/ 2 % formic acid, 1 % propionic acid, Biosil, Silasil-G, Silostar-G, Kofasil M</th>
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<tbody>
<tr>
<td><strong>Storage in</strong>: 1.5 and 120 l model silos, clamp silo, plastic tube <strong>Storage period</strong>: 2 weeks to 2 years</td>
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<tr>
<th>Removal</th>
<th>Fibre strength, fineness, elongation</th>
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| Pilot plant | with a processing capacity of 1 t fresh matter/h |

| Product production | Defibratation, drying, binder application, fleece formation, press forming, conditioning, inspection, assessment |

**Fig. 1.** Studies of the preservation of chopped hemp in a moist product line

1 pav. Smulkintų kanapių silosavimo tyrimo schema
Hemp of various varieties was cultivated on the trial fields of ATB Bornim [21].

Problems were to be expected in the field of harvesting machinery because of the extreme properties of the product (haulm length, tendency to wrap). Within the context of the examinations conducted, four chopper variants were examined and assessed (Figure 1) [22].

For the model examinations the hemp was harvested with a mounted field chopper CHAMPION 1200 from Messrs. KEMPER and chopped to lengths of approx. 3–5 cm, stored in model silos, compacted manually and stored for up to one year.

For examinations under practical conditions hemp was harvested on areas of 3.0 to 5.0 ha using the field chopper JAGUAR 850 and chopped to an average length of 15 mm. The chopped hemp was taken into storage in both mobile silos and in plastic tubes, with and without additives. The changes in the hemp during storage were examined continuously over one and two years.

The pH value, dry matter, sugar and crude fibre contents, as well as the fermentation acid spectrum (C2-C6) were determined from the samples drawn regularly. In addition, sensory testing of the samples was conducted and the storage losses were determined. The strengths, elongation and fineness of the ensiled fibres were determined [23, 24]. A pilot plant with a processing capacity of 1 t/h was built up with EU support and first products made of preserved hemp were produced.

**Results and Discussion**

**Harvesting.** It is expedient to harvest hemp intended for anaerobic storage between mid-August and the beginning of September. As of mid-September it is no longer possible to compact the material so strongly. The volumes taken into storage are reduced to approx. 75 % of the volumes harvested in August. Field choppers available on farms are suitable to varying extents. The basic prerequisites are a suitable cutter unit, sharp chopper knives, and a precision-adjusted shear blade. The further process cycle with transport and storage intake is unproblematic and comparable with that for producing silage.

**Preservation.** The varieties Fedora 17 and 19 and Felina 32 and 34 are particularly suitable for preserving chopped hemp via anaerobic storage, thanks to their higher sugar contents of between 4.0 and 5.8 % DM. Preservation processes start in chopped hemp even without additives. Alkaline and acid additives intensify the effects. Prior to removal the hemp must have been stored under anaerobic conditions for at least 2 to 4 weeks before it can be processed further. The storage losses determined lie between 0.5 % and 3.0 %. They increase continuously in line with the duration of storage and can be reduced by ensiling additives. No relation could be determined between variety and losses. Various storages of hemp were possible: clamp silo, stack silo and plastic tube.
**Fibre properties.** The strengths of the hemp fibres determined for harvesting fluctuate between 20 and 30 cN/tex depending on the variety and the harvesting period. These strengths are reduced by up to 50 % as the duration of preservation increases (Figure 2). The sticky substances are broken down during anaerobic storage and the fibre bundles become isolated. That is why the fibre fineness increases as expected. The fineness of the fibre bundles is approx. 230 tex prior to anaerobic storage, and in the range of 300 to 500 tex after storage for 6–12 months. The elongation at rupture only changes insignificantly. It fluctuates by 2 to 5 % between storage intake and outtake.

![Graph showing changes in fibre properties](image)

**Fig. 2.** Changes of fibre properties during the storage of hemp

**Potential applications.** Despite the reduced strength properties, the hemp fibres can be used to produce various semi-finished products and final products for the automobile, building and plastics industries [25] (Figure 3).

The essential process steps comprise defibration of the preserved material, drying, binder application, fleece forming and press forming. The first product produced in a pilot plant consisted of insulation (LDF) and MDF panels typical for building construction purposes but made of 70 % preserved hemp with the addition of 30 % wood fibres. The mechanical characteristics (bending strength, breakage properties) are comparable with those of standard, commercial, subsonic insulation and MDF panels on a wood basis. An initial costing indicates that the production of insulation panels would be cost-effective too.
Conclusions

An alternative process to conventional fibre production from dry fibre straw is to be developed making it possible to produce various products by processing preserved hemp. The new process is largely independent of weather conditions and fits well in the production cycles of farms. By comparison with the dried matter line, the final products are made from whole plants so that no waste products result. A patent has been applied for [26]. In a pilot system with a processing capacity of 1 t fresh matter/h various process parameters have been examined and optimised and assessed under economic aspects.

References


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**SILOSAVIMAS – NAUJAS KANAPIŲ KONSERVAVIMO METODAS**

**Reziumė**

Silosavimas – naujas kanapių konservavimo metodas. Šiuo metu naudojama kanapių nuėmimo technologija numato nupjautos produkcijos vytinimą lauke ir šiaudelių mirkymą pluoštui gauti. VFR sąlygomis kanapės pjaunamos rugsėjį, kada orai nepalankūs nupjautai masei džiovinti lauke. Leibnico žemės ūkio technikos institute parengta nauja kanapių nuėmimo ir saugojimo technologija, leidžianti iki minimumo sumažinti neigiamą blogų orų poveikį. Pagal šią technologiją kanapės pjaunamos bei smulkinamos savaigiai pašarų kombainais ir silosuojamos polimerinėse rankovėse. Nustatytas pagrindinių pluošto savybių
Pokytis saugojimo laikotarpiu. Institute sukurta kanapių pluošto perdirbimo nauja technologine linija, gaminant iš jų izoliacines bei konstrukcines plokštes. Linijos našumas – 1 t/h perdirbto kanapių pluošto.

Kanapės, pluošto perdirbimas, silosavimas.

К. Идлер, Р. Пеценка

СИЛОСОВАНИЕ – НОВЫЙ МЕТОД ХРАНЕНИЯ КОНОПЛИ

Резюме

Общепринятая технология уборки и хранения конопли предусматривает высушивание скошенных растений в полевых условиях с последующим вымачиванием соломы для получения волокна. В условиях ФРГ коноплю убирают в сентябре, когда погодные условия не благоприятствуют ее полевой сушке. В институте сельскохозяйственной техники им. Лейбница разработана новая технология уборки и хранения конопли не зависящая от погодных условий.

Урожай конопли скашивается и измельчается самоходными кормоуборочными комбайнами с последующим силосованием измельченной массы в пленочных рукавах. Измельченная конопля после хранения поступает на экспериментальную линию производства изоляционных матов или прессованных волокнистых плит. Производительность линии 1 т/ч готовой продукции.

Конопля, обработка волокна, силосование.