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UTILIZATION OF PASTEURISATION LIQUID OBTAINED FROM CHESTNUT (*Castanea sativa)* SAWDUST AS WOOD PRESERVATIVE

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Abstract

In mushroom cultivation, one of the most important steps is the pasteurization or sterilization. Primarily; all raw materials such as various kinds of wood sawdust or agricultural wastes used as substrate medium are required to be pasteurized. During the process, pasteurization liquor is generally dumped without re-cycled. In this study it was investigated that the fungicidal effect of pasteurization liquor of chestnut (Castanea sativa) sawdust, which is particularly rich in tannins, against brown rot fungi "Coniophora puteana". The wood samples were impregnated with the pasteurization solution according to the ASTM D 1413 standard test method. The protective effect of this liquor on Scotch pine (Pinus sylvestris L.) wood was considered by means of fungi decay test (EN 113). It was concluded that the pasteurization liquor enhanced the decay resistance of Scotch pine sapwood samples compared to the control group.
Keywords: Chestnut (Castanea sativa), Coniophora puteana, fungicidal effect, pasteurization liquor, wood decay

KESTANE (Castanea sativa) TALAŞI PASTORİZASYON SIVISININ ODUN KORUYUCU OLARAK DEĞERLENDİRİLMESİ

Öz

Mantar kültivasyonunda en önemli aşamalardan biri pastörizasyon ya da sterilizasyondur. Öncelikle; her türlü odun talaşı ya da zirai atık gibi substrat ortamı olarak kullanılan bütün hammadde kaynaklarının pastörize edilmesi gerekmektedir. Proses sırasında, pastörizasyon sıvısı genelde geri dönüşüme kazandırılmadan atıl bırakılmaktadır. Bu çalışmada özellikle tanen bakımından zengin olan kestane (Castanea sativa) talaşı pastörizasyon sıvısının, Coniophora puteana, esmer çürüklük mantarına karşı fungusidal etkisi araştırılmıştır. Odun örnekleri, pastörizasyon sıvısı ile ASTM D 1413 standart test metoduna göre emprenye edilmiştir. Söz konusu sıvının sarıçam (Pinus sylvestris L.) odunu örnekleri üzerindeki koruyucu etkisi EN113 mantar çürüklük testine göre değerlendirilmiştir. Sonuç olarak; pastörizasyon sıvısı sarıçam diri odunu örneklerinin çürüklük dayanımını kontrole oranla artırmıştır.
Anahtar Kelimeler: Kestane (Castanea sativa), Coniophora puteana, fungisidal etki, pastorizasyon sıvısı, odun çürüklüğü

1 Introduction

Preservation of wood and wood-based panels against biological agents mostly requires the use of synthetic chemicals which generally caused environmental problems. However; extractives isolated from naturally resistant wood species may be an alternative approach in pesticide control because of their bioactive components. This type of natural wood extracts is also biodegradable and non-toxic [1]. Chestnut wood (Castanea sativa) can be considered as one of the natural sources which have beneficial bioactive properties. Castanea sativa is a tree belonging to the Fagaceae family, living in generally Mediterranean regions of Europe. It is a good source in terms of phenolic bioactive compounds, especially in tannins [2]. Its leaves have been widely used, in folk medicine, for some diseases such as bronchitis, asthma, cough[3, 4]. Calliste et al. (2005) described that its leaves as a source of natural antioxidants [3]. Additionally; an extract obtained from Castanea sativa bark has been shown antiviral effect against various viruses [5].

Pasteurization is a partial thermal sterilization process used to destroy specific pathogenic microorganisms. It has often been confused with sterilization [6, 7]. Unlike sterilization, pasteurization only eliminates pathogenic microorganisms and not intends to kill all micro-organisms. It aims to reduce the number of viable pathogens so they are unlikely to cause disease. Sterilization is also another form of thermal process which uses comparatively high temperatures and eliminates (removes) or kills all forms of microbial life, such as fungi, bacteria, viruses, spore forms, etc [7]. Generally, sterilization temperature changes between 110° C and 120 ° C while pasteurization temperature changes between 70 to 80 °C [8]. According to the common belief; the more heat and longer durations are always better [6]. On the other hand; Sanchez (2010) noted that compost used for the Pleurotus mushroom cultivation do not necessary sterilization, but only pasteurization, which is cheaper to diminish the damages produced by different pathogens on mushroom yield [9]. Diana et al. (2006) suggested disinfection process of the substrate before spawning that should only destroy the competitive fungi and not the useful micro-organisms [10].

Quimio et al. (1990) realized that sterilization of the substrate medium is not ideal because both useful and harmful organisms in the substrate are killed [11]. Miroslawa (1991) recommended maintaining the substrate at 70°C, for 24 h [12].

Kwon and Kim (2004) informed that the accurate sterilization duration and temperature depend on the possible pathogens presented in the substrate medium [13].

In mushroom cultivation, one of the most important steps is the pasteurization. All raw materials such as various kinds of wood sawdust or agricultural wastes used as substrate medium are required to be pasteurized. During the process, pasteurization liquor is generally dumped without re-cycled. The aim of the experimental researches is to define the possibilities for utilization of pasteurization liquor of chestnut sawdust as wood protection solution against wood destroying fungus. For that reason; it was investigated that the fungicidal effect of pasteurization liquor of Castanea sativa sawdust, which is particularly rich in tannin, against brown rot fungi "Coniophora puteana".

2 Material and Method

2.1 Wood Materials

Scotch pine (Pinus sylvestris L.) wood was obtained from Black Sea Region of Turkey. The wood was cut in parallel to grain directions and sawn into specimens measuring 1.5 x 0.5 x 2.5 (tangential x radial x longitudinal) cm long. All specimens were conditioned at 20 ± 2 °C and 65 ± 3% relative humidity conditions until their weights became stable.

2.2 Extractive solution

1 kg Chestnut (*Castanea sativa*) sawdust was treated in 10-liter hot water at 80 °C for 1.5 hour on a baking oven. After pasteurization (1.5 hour) process, sawdust samples were filtered. Pasteurization liquor of chestnut sawdust was used directly as wood impregnation solution

2.3 Impregnation Method

The impregnation procedure was applied according to the ASTM D 1413 (1988) [14] standard test method. The wood samples were impregnated with the extraction solution in a medium scale impregnation container using a vacuum of 630 mm of Hg for 30 min followed by 60 min 7 bar pressure. Treated samples were then removed from the treatment solution and weighed to the nearest 0.01 g to determine gross retentions. Untreated blocks were used as controls. The retention was calculated using the following Equation (1);

$$R = (G\ x\ C/V)\ x\ 10\ \text{kg/m}^3 \quad (1)$$

where;

R: is the retention in kg per cubic meter

G: weight in gram of the treating solution absorbed by the samples obtained by subtracting the weight of the samples after treatment from the weight of the samples before treatment

C: the concentration or solution strength of the treating solution in percentage

V: volume of the samples in centimeters

The treated wood blocks were stored in a conditioning room at 20 ± 2 °C and 65 ± 3 °C relative humidity until they reach stable weight before the decay resistance tests.

2.4 Decay Resistance Test

The fungal decay test was done according to the standard test method (EN 113, 1996), [15] using a brown rot fungus "*Coniophora puteana*" for both treated and untreated control samples. The dimensions of scotch pine sapwood samples were 3 cm long in longitudinal direction, 1.5 cm in tangential direction and 0.5 cm in radial direction. Four replicates for each treatment were used. The incubation time was approximately 7 weeks at 22 °C and 70 % relative humidity (Figure 1). After incubation, the samples were oven-dried (103 ± 2 °C) and weighed. The weight loss caused due to fungal attack calculated as follows Equation (2):

$$Weight\ loss\ (\%) = [(mo - md)/mo] \times 100 \quad (2)$$

Where:

mo is the oven dry mass prior to test and md is the oven dry mass after the test

Figure 1. Fungal decay test

3 Result and discussion

The average retention content (kg/m³) was given in Table 1. The weight losses (%) of scotch pine wood samples were given in Table 2 and Figure 2. Weight loss prevention ratio of chestnut sawdust pasteurization liquor as compared to the control group was given in Figure 3.

Table 1. Average retention content (kg/m³) of scotch pine test wood samples

	Average Retention (kg/m³)	Standard deviation
Scotch pine test wood	58	3,50

Yıldız et al (2016) found that the retention content of scotch pine wood samples impregnated with tobacco plant extract (*Nicotiana tabacum* L.) was 55 kg/m³ for 10 % concentrations [16]. Taşçıoğlu et al. (2012) recorded that the retention content of scotch pine samples impregnated with mimosa, quebracho and pine bark extracts were 91%, 95%, 90% kg/m³, respectively for 12 % concentrations [1].

Table 2. Decay resistance of scotch pine wood samples treated with pasteurization liquor

	Average Weight losses (%)	Standard deviation
Test	5.06	1.15
Control	21.45	2.60

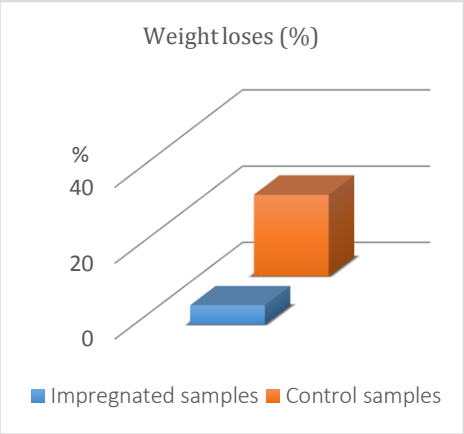

Figure 2. The weight losses (%) of test and Control samples

As can be seen in Table 2 and Figure 2; it was found that the average weight losses of impregnated test samples were lower than that of un-treated control samples. The pasteurization liquor of chestnut (*Castanea sativa*) sawdust exhibited a good performance approaching to meet the European norms.

The wood preservation with natural components against bio-deterioration is closely connected with the accumulation of extractives in the wood. The leading components of wood extractives are tannins, phenolic substances and flavonoids, exhibiting antifungal activities. They are often composed by the living tree as defensive compounds to environmental stresses [17].

Tascioglu et al. (2013) reported that mimosa (Acacia mollissima) bark extract and quebracho heartwood extract (Schinopsis lorentzii) have shown antifungal durability. These plant extracts are defined by their high tannin contents [1].

Şen (2001) observed that the effectiveness gallnut powder, valonia oak, and *Pinus brutia* bark extracts at different concentrations (1 %, 3 %, 5, %, 7 %, 10 %) as antifungal solutions on alder, spruce, beech and fir wood samples. He revealed that the plant extracts have high anti-fungal activity but poor fixation in laboratory tests and outdoor conditions. On the other hand; he determined anti-fungal activity against white-rot (*Pleurotus ostreatus*) and brown-rot (*Phanerochaete chrysosporium*) fungus at ≥ 4 % concentrations [18].

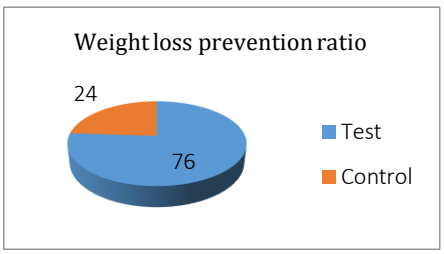

Figure 3. Weight loss prevention ratio of pasteurization liquor

According to the Figure 3; weight loss prevention ratio of pasteurization liquor of chestnut sawdust was 76 % as compared to the control group. Kirker et al. (2013) reported that using extractive obtained from naturally durable wood species prevent the growth of many pathogenic organisms such as insects, wood decay fungi, and mould fungi. They examined the additives of some extractives in durability of eight wood species compared to a nondurable control in laboratory for resistance to decay by brown/white-rot decay fungi and termite attack and they found that almost all of the wood species exhibited higher weight loss due to fungi and termite when extractives were removed [19].

To summarize the rest of the study it would be appropriate to say that; after five weeks; oyster mushroom (*Pleurotus ostreatus* and *Pleurotus citrinopileatus*) fruit bodies were harvested from the chestnut (*Castanea sativa*) sawdust substrate, successfully (Figure 4). According to the yet unpublished pre-analysis results; 100% *Castanea sativa* sawdust which used for *Pleurotus* species cultivation was exhibited high mushroom yield, high phenolic and tannin content and high antioxidant activity.

Figure 4. *Pleurotus ostreatus* cultivated on chestnut sawdust

4 Conclusion

In this study; it was investigated that the fungicidal effect of pasteurization liquor of chestnut (*Castanea sativa*) sawdust against brown rot fungi "*Coniophora puteana*". As a result of the study it was found that the weight losses of impregnated test samples were lower than un-treated samples. Weight loss prevention ratio of chestnut sawdust as compared to the control group was found as 76 %. The pasteurization liquor of chestnut (*Castanea sativa*) sawdust exhibited a good performance approaching to meet the European norms. The traditional protection systems are generally costly, non-eco-friendly and time-consuming techniques. As confirmed from the results; the natural extracts, can be an alternative approachment for wood protection industry. This type of components maybe in combination with synthetically prepared organic compounds. In order to produce more effective formulas; different natural species which are rich in extractive can be performed at different concentrations with more efficient extraction methodologies and techniques.

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