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DETERMINATION OF THE PRODUCT CONDITIONS OF PULP AND PAPER FROM WHITE MULBERRY (Morus *alba* L.) BY KRAFT METHOD

Ayhan GENÇER[1], Göksu ŞİRİN[2], Hülya GÜL[1], Ufuk ÖZGÜL[1]

[1]BÜ Faculty of Forestry, Department of Forest Industry Engineering, 74100 Bartın
[2]GÜ Almus MYO, Almus / Tokat

ABSTRACT

In this study, 3 different cooking were performed from white mulberry by kraft process, under the conditions such as; Active Alkali / Sülfidite rates, 16/20, 18/20 and 20/22, the temperature at 180ºC for 170 minutes. Physical and mechanical properties of the papers, produced at 20SRº, 35SRº and 50SRº were carried out. Physical properties were improved when the beating degree was increased at the same cooking conditions. Bursting and tearing resistance were increased. Paper pulp yield decreased with increasing the amount of total alkali.

Keywords: White mulberry (Morus *alba* L.), kraft method, pulp production

1. INTRODUCTION

White mulberry wood is native to China. It is distributed in Japan, Korea, Manchuria, India, Pakistan, Iran, North Europe and the Mediterranean countries. Capable of up to 15 m length, thick branches of a large tree that canopy. It is easy grown in deep soils, as well as in dry, sandy and chalky soils, endurance salt and cold weather conditions as a fast-growing species and usually likes warmer climate zones (Gökmen, 1973). It exists mostly in Erzincan followed by Elazığ, Ankara, Malatya and Tunceli, even can grow in every region. (Anon., 2002). Mulberry wood involves the colors from light brown to greenish brown, dark brown, brown or black and violet-colored, and has heartwood with (Merev, 1988). Chocolate Brown color yellowish-brown. The other properties are known that the annual ring limits are apparent, air-dry weight is 0.65 g/cm^3 (Bozkurt and Erdin, 1995), contents thyll formation as the same in other ring pored trees (Örs and Keskin, 2001).

*Yazışma yapılacak yazar: agencer@bartin.edu.tr
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When wood treated with cold and dilute alkali solution only a small amount lignin can be dissolved however, for the solubility of the lignin in wood significantly, if the wood chips are heated with NaOH solution under pressure, to 160-180 °C, most of the lignin is removed. This process is the base of the general commercial soda method (Browning, 1967). Alkali used in the methods alkali is consumed in lignin reactions, the solubilization of carbohydrates, naturally found in wood and neutralize organic acids formed during cooking, resinous substances and tannin reactions. (Tank, 1980). Mulberry tree has an important role in the history of the paper. The Chinese produced the paper from mulberry tree by peeling the inner bark, and by using lime and ash having alkaline property dissolved in water producing pulp which was beated in a mortar (Eroğlu, 1990).

Fiber length shows correlation with the properties of sound paper. For this reason, the first that comes to mind for the production of pulp of wood of coniferous trees. However, the strength of the paper is decreased after a certain point since the fiber length deform the paper formation. Therefore, short and thin-leaved wood fibers are preferred for many types of paper (Eroğlu, 2003). White mulberry belongs to ring pored trees in terms of sequence of trahe (Berkel, 1970). The average fiber width and lumen diameter of White Mulberry trunk wood was averages 15.33 μm, 52 μm (Şirin, 2006). Based on these results;

Runkel ratio = (Fibre wall thickness x 2) / lumen diameter (Kırcı, 2003), the formula
Runkel ratio = (8.81 x 2) / 6.52 = 2.702> 1
It was included in coarse fibers group

Some chemical properties of White Mulberry wood were investigated (Şirin, 2006) and the values determined were given in Table 1.

Table 1. Chemical analysis of trunk wood and branches of White mulberry (Morus *alba* L.) (Şirin, 2006).

The analysis	**Results (%)**
Cold water solubility	6,04
Hot water resolution	14,83
Resolution 1% NaOH	14,83
Alcohol resolution	11,13
Holocellulose rate	85,98
Cellulose ratio	53,08
Lignin ratio	21,30

It is suitable for the pulp production in terms of the cellulose ratio the same as it was in many broadleaved species.

2. MATERIALS AND METHODS

The test specimen was obtained from Inozu district of Ankara (Beypazarı) region located at 1000 m altitude, and the North-West direction. White mulberry wood first was chipped, and moisture content was determined, then weigh to 700 gas oven dry, afterwards stored in polyethylene bags. It is a fact that there is no available literature in relation to pulp production with mulberry wood previously. Since the kraft method is suitable for all types of wood it was chosen in this study. Pulp production was performed in a cylindrical boiler which is working with heating and resistant to pressure, rotating 2 cycles for per minute. Literature findings were based on the determination of the cooking conditions as well as temperature was maintained at 170 ° C. Cooking conditions are given in Table 2.

Table 2: Cooking conditions used in the study.

Active Alkali / Sulfite (%)	16/20(I)	18/20 (II)	20/22 (III)
Solids (%)	20.88	23.87	27.27
Solid content (g)	271	256.15	242.76
Moisture ratio (%)	12	12	12

The unbeaten paper was produced with 35 SRº and 50 SRº from the pulp, then, the paper thickness, surface smoothness, air permeability, tear resistance, and burst resistance properties were determined.

Test papers were conditioned under the temperature at 23±1 and relative humidity with 65 % according to TAPPI T402 om-88 standard for 24 hours in the room, followed by subjected to the tests given below. TAPPI T402 om-88 standard test papers obtained by the temperature and relative humidity of 23 ± 65% of the air in the first 24 hours after conditioning were subjected to the following tests,

1 .According to TAPPI 410 om-88 standard weight,

2. According to TAPPI 411 om-89 standard, thickness, density and volume,

3. Moisture according to TAPPI 412 om-90,

4. According to TAPPI 220 om-88 standard test paper cutting,

5. According to TAPPI 410 om-88, expressed in grams of 4-fold paper with founding tear resistance,

Tear resistance index = x (16/4) x 9.81 / weight,

Formula $mN.m^2$ / g calculated,

6. TAPPI 403 om-91 standards, determined by the bursting strength in kg/cm^2,

Index = 1000 x 0.0981 x Bursting resistance / Weight formula $kPa.m^2$ / g, respectively.

3. RESULTS AND DISCUSSIONS

Cook the paper pulp screened yield values obtained is given in Table 3.

Table 3: White mulberry wood screened pulp produced in yields.

Active Alkali / Sulfite (%)	16/20 (I)	18/20 (II)	20/22 (III)
Elimination yield (%)	38.44	36.60	34.68
Screen surplus (%)	2.00	0.61	0.70
Total yield (%)	40.44	37.20	35.38

In the first cooking, active alkali and sulfidity were chosen 16 % and 20 % respectively, the eliminated yield was determined to be 38.44 %. The eliminated yield values were given in Table 3.

The eliminated yield was determined to be 36.60 %. Active alkali was increased to 18 % and sulfidity to 22 % because of the decline in yield, and eliminated yield was calculated to be 34.70 %. Because the decline in the yield was taken in to account, active alkali and sulfidity were not increased, therefore recooking was not done. Table 4 shows some of the features white mulberry wood manufactured hand made sheets.

Table 4: White mulberry wood essay papers produced some of the features.

Cooking	SR^o	Surface Smoothness (ml/min)	Air Permeability (ml/min.)	Thickness (µm)	Tear index (nM. m^2/g)	Burst index (kPa.m^2 / g)
I (16/20)	20	781	>5000	176	102	0.53
	35	580	1925	131	281	1.77
	50	492	420	126	229	2.32
II (18/20)	18	829	>5000	180	121	0.52
	35	506	2443	142	255	1.76
	50	340	470	125	227	2.28
III (20/22)	20	717	>5000	176	125	0.54
	35	521	1757	140	280	2.06
	50	395	499	125	234	2.42

The paper testing is done based on the produced paper beating 50 SR^o When the paper produced 50 SR^o was examined for surface smoothness it was seen that decreased when NaOH ratio increased from 16 % to 18 % and air permeability increased at constant sulfidity 20 %. It may be caused by weakening of the fibers with burning affect of NaOH. Tear and burst resistance decreased at fixed sulfidity 20 %, when NaOH ratio increased from 16 % to 18 % However, it increased when the sulfidity was increased to 22 % at the same conditions. The

decline in the yield indicates that it is not possible to produce paper without giving loss in the part of carbohydrate with sulphate cooking solution. Hemicelluloses fractions having low molecular weight and labile to alkali merge in to cooking solution at the beginning of the cooking. Although cellulose component is the most durable polymer against alkali attack, 5 % of cellulose is dissolved during kraft cooking and merge in to cooking solution (Kırcı, 2003).

The loss in the yield caused from increased total alkali quantity might be resulted from cellulose degradation by alkali attack. Therefore, viscosity should be monitored in cooking by using lover alkali in the further experiments.

5. CONCLUSIONS

White mulberry has a high potential resource since it is distributed in a broad area in Turkey. It has sound wood, as well as can be used in the production of pulp and paper because of the high celluse content. Although kraft method is used in this study, further studies based on chemical, semi-chemical and mechanical methods are needed to get precise finding whether white mulberry suitable for pulp and paper.

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