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Studying the Optical Properties of Newsprint Produced from Canola Pulp Through Chemimechanical Pulping

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Abstract: This study was done in order to investigate the optical properties of chemimechanical pulp and paper produced from canola. Cooking process was implemented chemimechanical using up to 20 percent chemicals for 30, 40 and 50 minutes at 170°C. Pulps were then processed in laboratory refiner to reach freeness values of 300±25 ml CSF. Optical properties from hand sheet papers were finally measured based on TAPPI standards. results showed that optical properties such as opacity and brightness has been increased while some others like yellowness have been decreased as treatment process is intensified (at lower yields). Additional examination on the optical properties of chemimechanical pulp and paper reveals that the treated paper for 50 min using 20 percent chemicals has proved superior properties with opacity and brightness being significantly higher than that of others.

Key words: Canola · Chemimechanical Pulping (CMP) · Freeness · Opacity · Brightness · Yellowness

INTRODUCTION

Considerable shortage of wood materials required for wood and paper industries in our country has made it necessary to provide raw materials from non-wood resources. Statistical figures reveal a growing tendency to use agricultural residues to produce pulp due to the great benefits along with using these lignocelluloses [1]. In this regard, using non-wood renewable resources can perform as a possible solution to amend part of this shortage in lignocelluloses materials for Iran's wood and paper industries. Iran cannot arrange an extensive planning to employ wood lignocelluloses in paper products because of its characteristic climate and unpleasant condition of industrial forests. Thus, the majority of activities have been focused on agricultural residues and fast-growing plants [2]. Among these policies, canola stalk has attracted remarkable attention which highlights the urgency of research on making pulp from this accessible and inexpensive component to produce paper. Yousefi (2006) reported the average harvestable dry stalk of canola in hectare to be 2800 Kg [3], while Mollaii (2008) prompted to study feasibility of making bleachable canola pulp from its stalk. Results of chemical pulping process showed that canola stalks need more chemicals to make a bleachable pulp at low efficiency. They have also deduced that canola stalk is capable of being used in combination with softwood and hardwood pulps in order to enhance their surface properties and printability [4]. Ramezani (2005) directed a research aiming to obtain a pulp of bleached newspaper sheets from agricultural residues of canola through a method called CMP. Cooking the pulp by CMP was performed using 5 and 10 percent of chemicals at 160°C for 40min in order to reach the desired efficiency [5]. Pirouz (2006) studied canola pulp production by Neutral Sulfite Semi Chemical (NSSC) technique. The conditions of pulping through NSSC for producing hand sheet paper consisted of: 170°C of cooking time, 10 and 20 percent of chemicals, as well as 30 and 40min of cooking time. Thereafter, hand sheet paper of 127 g m^{-2} was produced from the pulp [6]. Salehi (2000) decided to examine chemimechanical properties of high-efficiency pulps taken from bagasse. Cooking procedure was done through CMP using 10, 15 and 20 percent of soda at 95°C during 10, 15 and 20min in order to reach the appropriate efficiency [7]. Resalati (2001) handled an investigation on relative capability of agricultural residues of straw from Mazandaran province,

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northern Iran, in making pulp utilizable for newspaper, print and redact. They prepared bagasse for newspaper sheet through a bleaching step up to 55 percent brightness using hydrogen peroxide [2]. Sadatiyan (2005) accomplished a study for preparing newspaper sheet from bagasse residues by CMP. Pulp cooking was implemented using 5, 10 and 15 percent chemicals at 160°C and 15, 10 and 45 min in order to give the required efficiency values [8]. These studies verified that no similar research has been directed abroad on canola pulping with chemimechanical methods. Taking into account the difficulties and limitations of supplying raw materials of pulping required for newspaper sheet production, recent developments of canola cultivation in Iran and the special look on this plant during recent years in addition to its invaluable residues, we attempted to examine the usability of canola chemimechanical pulp for producing newspaper sheets.

MATERIALS AND METHODS

Canola sample of the experiments was supplied from a farm located in Babol, Mazandaran, Iran and was carried to the pulp and Paper Research Center of Mazandaran in order to process the pulp. To obtain the pulp, Chemimechanical Process (CMP) was applied based on Table 1.

When cooking process is done, the pulp is rinsed and its efficiency was determined. The resultant pulp was then refined using PFI Mill laboratory refiner until reached the freeness degree of approximately 300±25 ml CSF and hand sheet papers with base weight of 60 g m^{-2} was prepared according to T220-Om88 instructions from TAPPI standard. Measurement of optical properties such as brightness, opacity and yellowness of the paper was done based on T452-Om98 regulations from TAPPI standard [9] by spectrophotometer apparatus of TECHNIBRITEMIRO TB-1C. Analysis of the results obtained on resistance characteristics of the hand sheet papers and classification of the average data was implemented with the aid of variance analysis and Duncan multiply range test (DMRT) statistical test methods using SPSS software.

RESULTS

Characteristics of the cooking process related to three different treatments are illustrated in Table 2.

Having considered the data from variance analysis table, it can be discovered that there is a meaningful difference between efficiency values of three studied pulps on 5 percent probability level. Moreover, comparing the average data revealed that the average efficiency of resultant pulps can be categorized in three different

Table 1: Characteristics of cooking process to give canola pulp through CMP

Cooking Condition	CMP Canola Pulp	Cooking Condition	CMP Canola Pulp
Liquor-to-wood ratio	10:1	Type of Chemical	Na_2SO_3
Chemical Used (%)	20	Cooking Time (min)	30, 40 and 50
Cooking Temperature (°C)	170	pH	6.8

Table 2: Process characteristics of chemimechanical cooking of canola

Cooking Conditions			
Cooking Temperature (°C)	Cooking Time (min)	Chemicals Used (%)	Average yields (%)
170	30	20	75.22
	40		72.10
	50		69.75

Table 3: Revolution speed requirements to reach final freeness degree, base weight and thickness of the papers produced

Pulp Group No.	Treatment	Revolution Speed (rpm)	Freeness Degree after Refinement	Base weight or Grammage (g m^2)	Thickness (μm)
1	30 min, 20 % chemicals	1200	312	60.21	127.58
2	40 min, 20 % chemicals	1250	305	59.95	127.42
3	50 min, 20 % chemicals	1350	295	60.10	128.52

Table 4: Optical properties of 60 g m^{-2} papers obtained through CMP

Treatment	Opacity (%)	Brightness (%)	Yellowness (%)
30 min, 20 percent chemicals	90.13^{b}*	30.24^{b}	25.07^{a}
40 min, 20 percent chemicals	91.02^{b}	33.45^{a}	23.01^{b}
50 min, 20 percent chemicals	92.15^{a}	33.25^{a}	20.40^{c}

*Note: Similar letters are indicative of no meaningful differences groups. For making a hand sheet paper, freeness contents of approximately 300±25 ml CSF is required. Table 3 has summarized some information about rotation speed of the refiner to attain final freeness degree in addition to base weight and thickness of the papers produced.

Comparing the average of measured opacity, brightness and yellowness values from three types of papers has been summarized in Table 4.

Comparison of average opacities shows that papers produced from treatment at 5 percent level are categorized in two different classes such that treatment in 30 and 40min with 20 percent chemicals are rated in one group while 50 min with 20 percent chemicals are rated in the other (Table 4).

DISCUSSION AND CONCLUSION

Regarding the efficiency, it was denoted that with increasing the cooking time, diffusion and absorption of the chemical into canola has been increased. Hence, the values of delignification has been increased in addition to the polysaccharide destruction particularly hemicelluloses which leads to lower efficiencies of the pulp. Meanwhile, this low efficiency causes pulp to be refined better during the refinement step and be able to reach the desired freeness degree at lower refinement rotation rates throughout the paper manufacturing procedure. Paper opacity was calculated as 92.15 when treated for 50min with 20 percent chemicals. Comparing this value with those reported by Sadatiyan (2005) and Ramezani (2005) reveals that the average opacity of canola straw is less than that of bagasse (94.29 percent) and canola straw of Gilan province (96.32 percent) [5, 8]. Paper brightness was calculated as 33.45 percent when treated for 50min with 20 percent chemicals. Comparing this value with those mentioned by Sadatiyan (2005) and Ramezani (2005) reveals that the average brightness of canola straw is less than that of bagasse (44.30 percent) and more than that of canola straw of Gilan province (31.63 percent) [5, 8]. Examination of the optical properties of papers obtained from chemimechanical pulps of canola shows that the paper yielded from treatment for 50min with 20 percent chemicals has provided better properties; it means that their opacity and brightness was higher than others. This can be attributed to the longer cooking time in comparison with other treatment regimes which causes chemicals to penetrate deeper through fibers and as a result the delignification will occur to a greater extent. Considering the low optical qualities of these papers such as low brightness and high yellowness, it seems that using them to produce newspaper sheets is impossible. But since the canola pulp has not experienced bleaching step, it can be expected that the optical properties of this hand sheet paper would be improved whenver bleached. Because canola is harvested as the second crop (after rice) in farms of northern Iran and it is produced continuously [10], it can be used as the lignocelluloses substance to make pulp and to balance part of the shortage in raw materials of this industry.

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