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A Comparison of Unbleached Pulps from Cherry Heartwood and Sapwood

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A COMPARISON OF UNBLEACHED PULPS FROM CHERRY HEARTWOOD AND SAPWOOD

by

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ABSTRACT

The purpose of the project was to evaluate pulps made from cherry heartwood and sapwood.

The amount of heartwood a tree has is an individual trait of the tree rather than a function of geography or environment. Tree breeders can, through selection, reduce or increase the amount of heartwood if it is economically justifiable.

Three cherry logs with 50 - 50 heartwood to sapwood ratio were barked and chipped at S. D. Warren Company in Muskegon. The chips were separated, heartwood from sapwood, by the color difference.

The chips were cooked using 20% active alkali, 6 to 1 liquor ratio, for 1.5 hours at 175°C using an oil bath digester. The oil bath digester had six cartridges of which three were charged with heartwood and three with sapwood.

The average yield for heartwood was 44.8% and the average yield for sapwood was 52.7%. The difference in yield was the most significant difference between heartwood and sapwood.

The brightness of the sapwood was about 5% greater than heartwood. The Kappa number of the heartwood was 20.8 compared to 22.0 for sapwood.

The mullen of heartwood was greater than the sapwood in the freeness range of 100 to 500 C.S.F. by 12 to 16%.

The tensile of heartwood was greater than the sapwood in the freeness range of 150 to 500 C.S.F. by 4 to 8%.

The tear of sapwood was greater than heartwood in the freeness range of 100 to 500 C.S.F. by 14 to 18%.

You cannot totally eliminate either heartwood or sapwood and the resulting trade-off of advantages of increasing or decreasing the percent of heartwood would likely result in only a couple percent advantages in a few parameters. Therefore, the conclusion of this paper is to leave the ratio of heartwood to sapwood to nature.

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INTRODUCTION

Axe handles are made best out of trees with little sapwood. The trained eye can separate a tree with little sapwood from other trees and thus be able to pick a good tree to make axe handles out of. The parallel of making axe handles out of heartwood is making paper out of heartwood. It would seem that pulps made from heartwood and sapwood would have different properties even though they are made up of the same basic fibers. The object of this study is to find out how these properties vary with pulp made up of heartwood to pulp made of sapwood. The overall objectives to find if pulp made up of sapwood is superior or not to heartwood pulp.

BACKGROUND DISCUSSION

Heartwood is formed when lignin like particles clog the pits of the cells in the border region between the heartwood and sapwood. In the article by R. L. Krahmen and W.A. Cote, Jr. the mechanism for pit closure in the heartwood is attributed to border area pit aspiration and deposition of lignin like substances in the openings of bordered pit pairs (3). With the increased concentration of lignin like particles it would seem that it would be harder to pulp and bleach heartwood.

In most cases, the extractives content increases considerably when sapwood is transformed into heartwood (2). Since the density of heartwood is greater than sapwood, in the same tree, material must be translocated to the heartwood pieriphery when the transformation occurs. The different amount of extractives are what accounts for the greater resistance to fungi and termites.

A couple of procedures to test for heartwood were given by R. G. Rickey and H. L. Hergert in their article (1). One way was to mix equal volumes of 1% benzedrine hydrochoride and sodium nitrate solutions and pour the solution on the wood. In 15 to 30 minutes a brick-red zone will be where the heartwood is. Benzedrine, due to its carcinogenicity, is not safe to use. O-anisidine can be safely substituted.

Another way to separate heartwood from sapwood with the wood in the form of chips is to observe the chips under ultra violet light noting the difference in color. The color of the chips can change with different woods and chemicals can be sprayed on the chips to get a more noticeable color difference. In order to keep from inducing errors by coating chips with chemicals to separate heartwood and sapwood, the difference in color of heartwood to sapwood in daylight was used to separate the chips in this study.

Pulping of heartwood is dependent upon the amount of stilbenes (1). It was found in a study of reactions of heartwood during acid bisulfate pulping that a content of 0.1% stilbenes as in Lodgepole pine would not be sufficient to block pulping (complete pulpability), while a content of 0.5% or more stilbenes results in no pulping what so ever (inhabition) (1). In this study, the kraft process was used as no evidence was found where there was trouble pulping heartwood.

Soaking the wood in neutral solvents to remove extractives from the cell lumen can be successfully done to a degree as it is these extractives which gives heartwood a number of distinguishing qualities (2). Permeability of heartwood does increase with extraction but it does not ever gain the permeability (air permeability) of sapwood (3).

Variation of trees was a major factor in the literature cited. One example is that White Pine, in the study of heartwood in Bisulfate pulping, had results which ranged from complete pulpability to inhabition (1). Clear back in 1941, G. H. Chideston and J. N. McGovern

stated that there is a considerable difference in wood between the butt and top portions of the same tree (4). The butt portions of the tree pulped harder than the top portions.

In a study on variations of Sweetgrum by A. G. Hunter and S. F. Goggans, specific gravity, extent of colored heartwood, radial growth rate and total age of the tree were measured.

Samples were taken from trees at breast height from 87 plots in Alabama. It was found that most of the variations were from tree-to-tree rather than from plot-to-plot. The final conclusion of the study was that geographics and environmental differences had no significant effect on the amount of heartwood. The article also stated that some trees had no heartwood for up to 36 years old and tree breeders, through selection, might be able to reduce the amount of colored heartwood. There was no correlation found between percent colored heartwood and specific gravity in Sweetgum up to 40 years old. The total age of the tree and percent colored heartwood were significantly correlated, but increasing age did not necessarily mean more colored heartwood.

The big item in the article on the variations in Sweetgum is that the amount of heartwood is an individual trait of each tree which is not determined by the environment or geographics and tree breeders, through selection might be able to reduce the amount of colored heartwood. The end result being that, if it is economically justifiable, the amount of heartwood could be reduced.

EXPERIMENTAL PROCEDURE

Three logs with about 50 - 50 heartwood to sapwood ratio and distinct colored heartwood were choosen at S. D. Warren's woodyard in Muskegon. The logs were hardwood cherry trees. The logs were barked, chipped and bagged.

The chips were separated by hand using the color difference from heartwood to sapwood. The moisture of the heartwood chips was found to be 9.64% and the sapwood to be 14.2%.

The chips were cooked using an oil bath digester with three cartridges for heartwood and three cartridges for sapwood so as to have equal cooking conditions. The chips were cooked for 1-1/2 hours at 170°C with active alkalie at 20%, 6 to 1 liquor ratio, sulfidity of approximately 20%, and with 120 grams of bone dry chips per cartridge.

The yield was calculated after the lignin was washed out of the pulp on a small side hill screen by weighing the pulp and then finding the percent moisture.

Beater curves were made using refiner times of 5, 15, 30 and 45 minutes in the Valley beater. The C.S.F. (Canadian Standard Freeness) was tested at the end of each period and Noble and Wood handsheets which weighed 3 grams each were made. The sheets were tested for tensile, GE brightness, mullen and tear.

The Kappa number for the two pulps was obtained using TAPPI Standard T-236.

PRESENTATION OF RESULTS

The data which was used to form the beater curves is summarized in Table I. The beater curves are Figures 1 through 4. Figure 1 is the tear curve. Figure 2 is the tensile curve. Figure 3 is the mullen curve. Figure 4 is the brightness curve.

The percent yield for sapwood averaged 52.7%. The percent yield for heartwood averaged 44.8%.

The Kappa number of the sapwood was 22.0 and the Kappa number of the heartwood was 20.8.

DATA TABLE

Heartwood

	Freeness CSF			
	615	492	290	87
Tear	46.4	52	52	44
Tensile	8.2	13.7	17.7	12.8
Mullen	17.2	46.0	60.2	50.2
Brightness	30.4	28.7	26.2	24.5
Refiner Time	5 min.	15 min.	30 min.	45 min.

Sapwood

	Freeness CSF			
	686	522	281	119
Tear	23.6	52	61	54
Tensile	6.5	12.6	17.0	14.1
Mullen	12.7	36.8	46.9	50.5
Brightness	32.7	31.0	27.6	23.5
Refiner Time	5 min.	15 min.	30 min.	45 min.

FIGURE 4

TEAR vs FREENESS

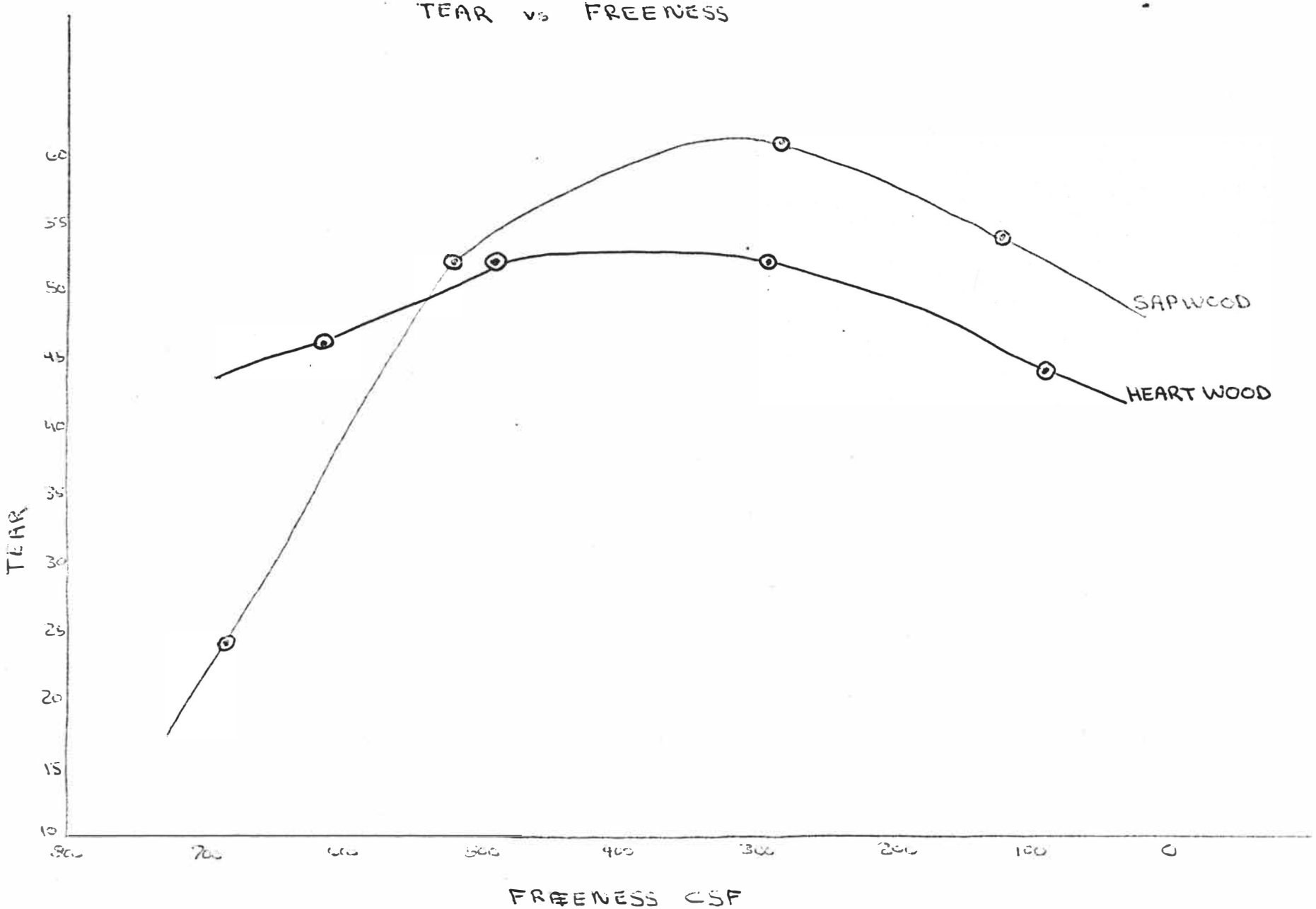


FIGURE 2

TENSILE vs FREENESS

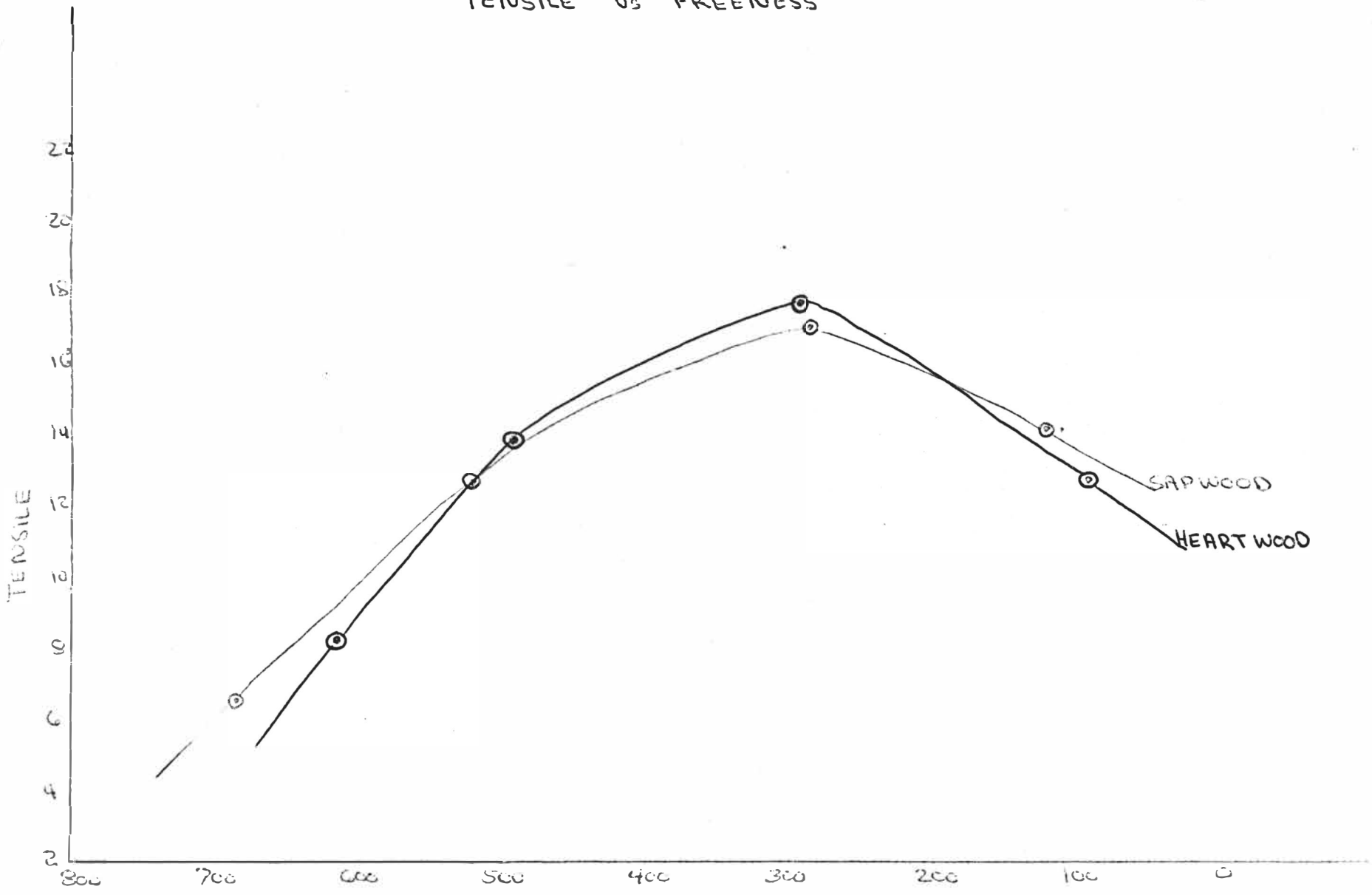


FIGURE 3

MULLEN VS FREENESS

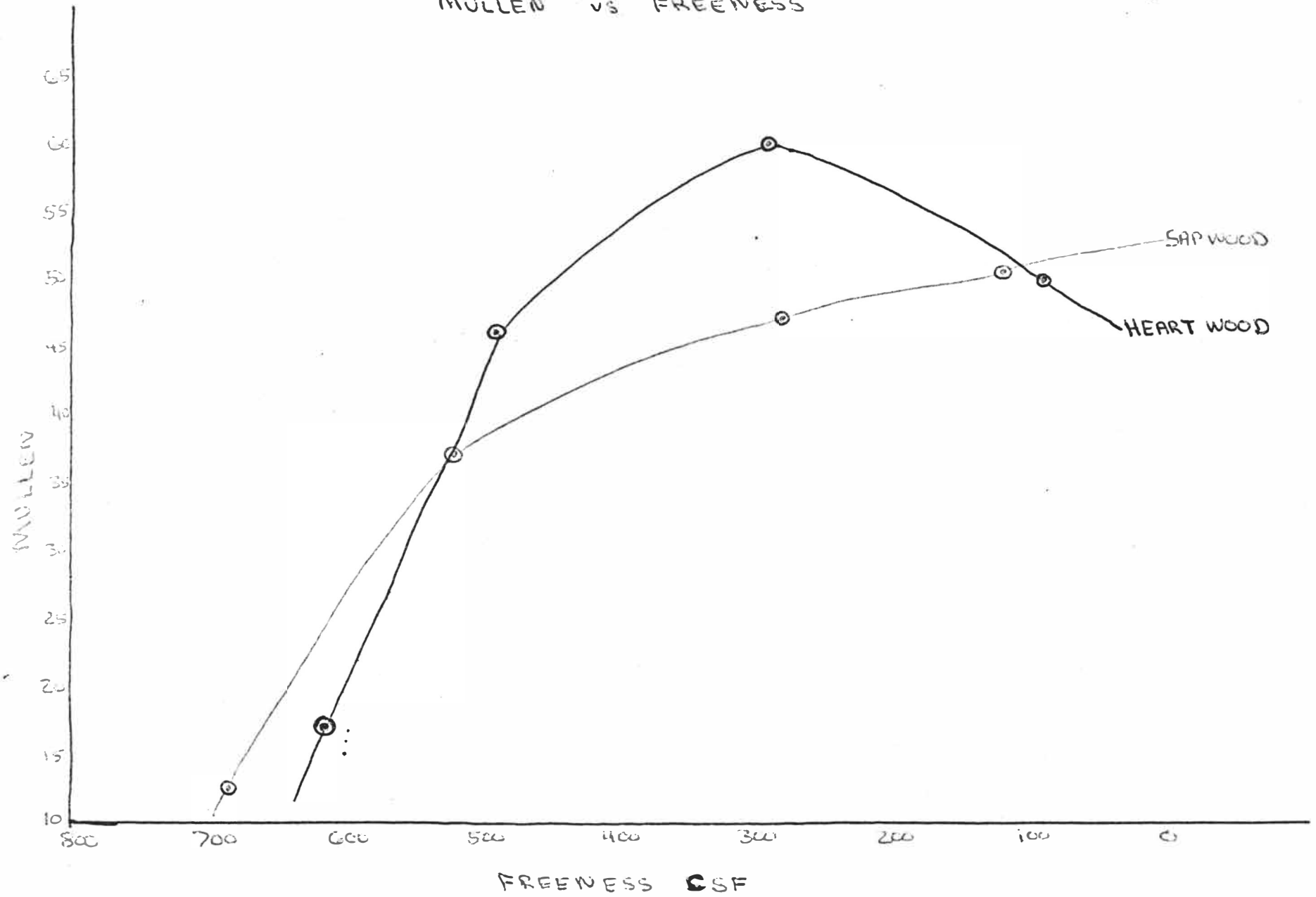
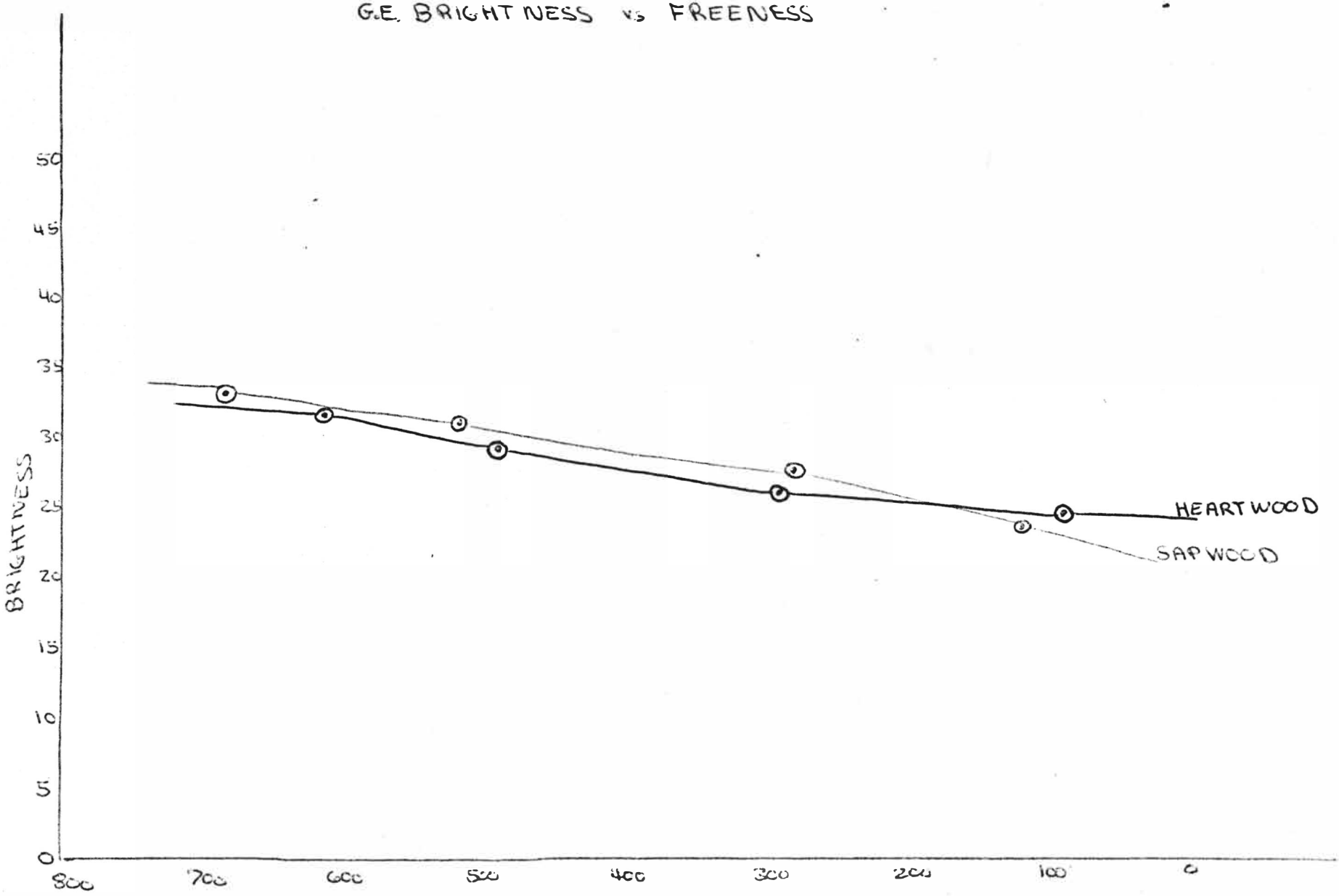


FIGURE 4

G.E. BRIGHTNESS vs FREENESS



DISCUSSION OF RESULTS

The most significant result of this study was that sapwood had an 8% greater yield than heartwood. The advantage of increasing the amount of sapwood by the increased yield is easy to see.

The Kappa number of the sapwood was 22.0 where as the Kappa number of the ~~sapwood~~ heartwood was 20.8. The difference in Kappa number is only 1.2 which means that it takes about as much chemical to bleach either heartwood or sapwood. It would have seemed -hat it would have taken more chemical to bleach the heartwood since the reason it is heartwood is, it has lignin like material in its pits.

The mullen of the heartwood was greater than the sapwood in the freeness range of 100 to 500 C.S.F. by a maximum of 16% (Figure 3). As would be expected, the tensile of the heartwood was greater than the sapwood by a maximum of 8% in the freeness range of 100 to 500 C.S.F. (Figure 2). The tear of the sapwood was greater than the heartwood in the range of 100 to 500 C.S.F. by a maximum of 18% (Figure 1). The strength tests reveal a trade of tear V.S. mullen and tensile as would be expected. Due to the trade offs in strength, the reduction or increase in heartwood would not have full justification.

The brightness of the sapwood was greater than the heartwood as would be expected, but only by 5% maximum (Figure 4). The pulps looked like night and day while the pulps were still in the bucket after washing. The heartwood looked darker than the heartwood.

CONCLUSIONS

The conclusion of this study is that there is little reason to try to change the ratio of heartwood to sapwood as the gains would not pay off. The only major advantage to gain would be yield. Suppose the amount of heartwood was reduced by 10%. The result would be an increase in the yield of 1% which I do not think is worth the effort. The only thing which might be done is to cut the trees early as the sapwood content would be greater and thus increase the yield.

RECOMMENDATIONS

A study taking a young tree and an old tree and doing a comparison study to check the effects and possible gains of earlier harvesting.

Another possible parameter would be to check different ratios of heartwood to sapwood to see if there is a happy medium.

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