11.

EUCALYPTUS FROM PORTUGAL FOR PULP AND PAPER

Rui Ferreiro Ribeiro, Director, Portucel, Portugal
Alberto Frazão, Director, Portucel, Portugal

Eucalyptus has been known in Portugal since 1829, and the main species are e.Globulus, e. Camaldulensis and e. Maideni.

Portuguese climatic and soil conditions are highly favorable for e. Globulus and it was therefore natural for the industry to look to eucalyptus as a raw material for pulp production. Pioneering work, using the bisulfite process, was performed in 1906 by Caima Pulp, then producing pine pulp, and regular production started at the company's mill near Albergaria in 1923. The big impetus to eucalyptus use in the pulp industry came with the start-up of bleached sulfate pulp production in the Cacia mill of Companhia Portuguesa de Celulose, in 1957, following laboratory studies made also in Cacia in 1956. In June 1958, the Cacia laboratory also studied, with good results, the production of dissolving pulps using prehydrolysis.

PORTUGUESE PULP EXPANSION: In 1964, Sociedade Industrial de Celulose, Sarl (SOCEL) whose biggest shareholder was Companhia Portuguesa de Celulose, Sarl, started up a mill for the production of bleached eucalyptus sulfate pulp near Setubal. Companhia de Celulose do Ultramar Portugues had a mill operating in Angola, using eucalyptus Saligna, since 1961.

In 1967 the Leirosa mill of Celbi, which initally planned the production of dissolving pulp, started producing paper grade pulp. In 1969, a new pulping line, including continuous digester and bleaching plant, was installed in Cacia. Meanwhile, Caima Pulp's new mill started in Constança. The unbleached kraft pulp mill of Celtejo and the kraft linerboard mill of Celnorte then started up in 1971 and 1974 respectively. With the expansion at Cacia and Setubal completed, Portucel, EP--resulting from the merger of Companhia Portuguesa de Celulose, Socel, Celnorte, Celtejo and Guadiana--is now producing 350,000 tons/yr of bleached eucalyptus market pulp in Setubal and Cacia.

Eucalyptus is also used in the production of some of its 110,000 tons of semi-bleached and unbleached sulfate market pulps as well as in its paper mills to make kraftliner, corrugating medium, kraft sack and other paper grades.

For an annual total production of 250,000 tons of paper, close to 100,000 tons are integrated in our five corrugated box plants. Our kraft sack paper, with eucalyptus pulp incorporated, is also used in one sack plant in Cacia as well as in others in Portugal, with good results.

FORESTATION IN PORTUGAL: Eucalyptus Globulus in Portugal today covers an area of 300,000 Ha, with an increase of 15,000 Ha/yr up to 1974 and 5,000 Ha/yr from 1974 until 1979.

An additional area of 500,000 Ha is still available for eucalyptus production, but it is desirable for ecological reasons to use only 250,000 Ha of it. This means that a total forested area of 550,000 Ha will be available, representing an annual production of 7,000,000 to 8,000,000 Stere (piled m^3), equivalent to 1,700,000 tons/yr of fully bleached pulp.

In certain areas the growth reaches 40 ST/Ha/yr, with a minimum of 3 to 5 ST/Ha/yr and an average close to 13.8 ST/Ha/yr, equivalent to about 3 tons of fully bleached pulp (4.6 ST of wood is equivalent to 3.04 solid cubic meters per ton of fully bleached pulp).

At present an intensive program of forestation is being prepared, and our company is particularly involved, with plans to forest 10,000 Ha/yr.

The structure of forest ownership in Portugal is mainly based on private land divided in small properties which represent 80% of total production. One of the main objectives of the forest plan being started in Portugal is to rationalize the utilization of the existing forest, promote the association of small forest owners and improve the forestation and extraction activities.

Our forestation activities are based on tree farms where trees for plantation are obtained from selected seeds, according to well proved techniques. One kg of eucalyptus Globulus seeds produces from 80,000 to 120,000 plants, and one Ha of forest at the cutting stage can produce from 3 to 5 kg of seeds. The small trees are planted when their height reaches from 20 to 30 cm, that is after 4 to 6 months in the tree farm.

Great care is required for the transportation of the small plants. A convenient soil preparation, building of roads to facilitate future exploitation, and an adequate protection against fire are also needed.

Plantation goes from end of October until the end of May (in areas with sandy soil as well as in cold zones, plantation is suspended from December until mid-February).

When paper pots are used, planting machines can be utilized and in this case the productivity is five times greater than planting by hand.

During the first two years after plantation, care has to be taken to avoid the occurrence of spontaneous vegatation around the small trees.

The age of plants ready for cutting varies with the ecological areas. Studies made on the river Tagus basin gave the following yields for the consecutive cuts:

1st cut - 8 to 13 m^3/yr/ha
2nd cut - 11 to 16 m^3/yr/ha
3rd cut - 9 to 11 m^3/yr/ha
4th cut - 7 to 9 m^3/yr/ha

PORTUCEL TODAY: The pulp, paper and packaging production of Portucel is distributed in mills located according to raw material supply and market.

Cacia, 60 km south of Oporto, is a partially integrated mill producing 120,000 tons of bleached eucalyptus market pulp, 30,000 tons of semi-bleached eucalyptus and pine market pulp, 25,000 tons of market kraft sack paper, 20,000 tons of corrugating boxes, and about 30,000,000 sacks/yr. All paper used in converting operations is produced in the mill, except for the KLB produced in Viana.

Setubal, about 50 km south of Lisbon, produces about 230,000 tons/yr of fully bleached eucalyptus market pulp as well as 15,000 tons of corrugating boxes. A small paper machine, using knots pulp and corrugating waste produces about 10,000 tons/yr of paper for the corrugated box plant.

Viana, about 50 km north of Oporto, is an integrated kraft linerboard mill, with an annual capacity of 145,000 tons now being expanded to 195,000 tons/yr (Figure 1).

Rodao, near the border of Spain, and about 250 km west of Lisbon, produces 80,000 tons/yr of unbleached sulfate pulp from pine or eucalyptus.

Mourao, located south of Rodao, produces about 40,000 tons/yr of corrugating medium using eucalyptus soda pulp made from tree tops and branches as well as waste paper.

Portucel's packing division operates five box plants--Guilhabreu, Albarraque, Leiria, Cacia, Setubal--and currently produces 130,000 m2 of corrugated board.

Our present expansion plans include the increase of kraft sack paper production, fluting, woodfree printing and writing papers, and SC papers (wood-containing printing and writing papers).

With all this production eucalyptus is present. In the paper companies where Portucel participates--Prado and Fapajal, with over 90% of share capital, and Inapa with 23%--eucalyptus pulp is used for the production of woodfree printing and writing papers, folding boxboard, tissue, etc.

Presently, a new pulp mill with a capacity of 250,000 tons/yr of fully bleached pulp is being prepared, and start-up is due in 1982. In this project Portucel has an active participation.

E. GLOBULUS CHARACTERISTICS: Of the many species of eucalyptus, we utilize e. Globulus since it is the most suitable for pulp production (followed by e. Saligna and e. Maidenis).

For the soda pulp made in Mourao, we also use e. Camaldulensis (or Rostrata).

Tables 1 and 2 by the Chief Chemist in Cacia, Manuel G. Queiroz, and published in "Papier, Carton et Cellulose", show the superiority of e. Globulus over other species, a superiority based on chemical composition allowing for delignification with good yield conditions, and preservation of high amounts of hemicelluloses present. Bleached pulps also show a good combination of characteristics which make them most suitable for papermaking.

Average properties of bleached eucalyptus sulfate pulps from Cacia mill are given in Table 3

NSSC PULP FROM EUCALYPTUS GLOBULUS: Although unbarked chips from e. Globulus logs have been used for the production of sulfate pulp, with good results, the utilization of branches and tops has been unfeasible due to problems of transport and chipping.

Improvements in logging techniques, namely the whole tree chipping at the forest, can increase the amount of this material available for the mills and Portucel is planning its future use for NSSC pulping and for other high yield pulps, as well as fuel.

Experiments on the use of unbarked branches and tops of e. Globulus were made at the Cacia mill using the "vapurge" technique (pre-impregnation of chips under vacuum) with hot refining in disc refiners (roto speeds of 1,450 rpm). Depending on cooking conditions, the CMT test (kg) at 45° SR, varied from 26.5 to 32.5. Yield decreased with an increase in temperature, and 165° C was found to be the most convenient level.

Pulp obtained without pressure during impregnation showed a slight improvement in characteristics but with more difficulties in refining. All the tests made show that the pulp compares with most pulps available on the market. As

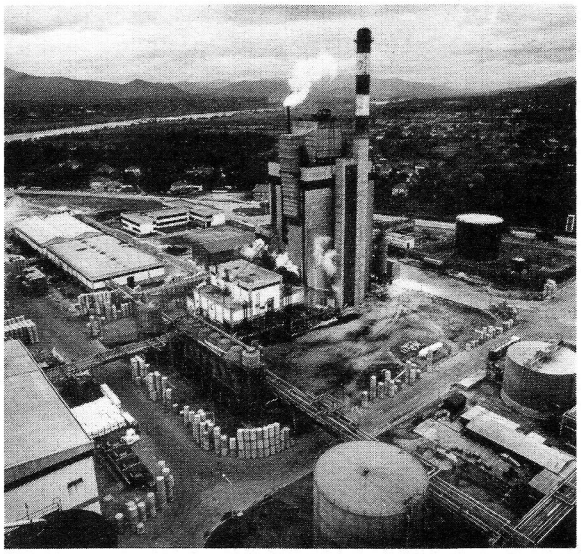

Figure 1

Table 1

SULFATE COOKING OF DIFFERENT EUCALYPTUS SPECIES														
	Temperature rising time h	Pressure = On h	Total time h	Max. Temperature Oc	Liq. Volume/ dry wood weight	Active Alkali/ dry wood weight	Sulfidity %	Activity %	Total yield %	Knots %	Residual Alkali Na_2O g./l	Residual Sulfur Na_2O g./l	Permanganate Number	Intrinsic Viscosity cm^3 / g.
E. GLOBULUS	2.00	1.00	3.00	160	4.0	0.161	23.3	89.2	57.4	0.1	3.3	7.9	12.8	1.370
E. CAMALDULENSIS	2.00	1.00	3.00	160	4.0	0.190	25.0	90.0	50.7	0.7	5.8	9.6	13.5	1.050
E. MAIDENI	2.00	1.00	3.00	160	4.0	0.170	25.0	90.0	59.4	1.4	1.6	12.6	12.8	1.120
E. SALIGNA	2.00	1.00	3.00	160	4.0	0.150	23.5	89.4	59.1	0.1	3.7	8.9	14.7	1.320
E. BOTRYOIDES	2.00	1.00	3.00	160	4.0	0.172	24.5	90.0	51.5	0.8	3.8	7.9	19.1	1.090
E. RUDIS	2.00	1.00	3.00	160	4.0	0.191	25.3	89.6	43.5	0.9	5.0	5.0	28.5	1.010
E. VIMINALIS	2.00	1.00	3.00	160	4.0	0.170	24.8	89.4	48.4	0.2	5.2	6.2	12.8	1.150
E. ALBA	2.00	1.30	3.30	156	4.0	0.151	24.2	88.7	50.7	0.8	1.0	5.1	17.5	1.270

Table 2

COMPARISON OF BLEACHING CONDITIONS FOR DIFFERENT EUCALYPTUS PULPS FROM EUCALYPTUS SPECIES												
	Bleaching Sequence	Chemical Consumption		Tests on Refined Pulps (Values interpolated to 45° SR)								
		Cl2 and Clo2 as Cl2	Na OH %	Brightness	Best colour Number (a)	Printing Opacity %	Turns	Apparent Density	Burst	Breaking Length m	Elongation	Tear Index
E. GLOBULUS	CEDED	5.4	2.7	92.9 (6)	0.31	80	15.570	0.760	87.5	13.310	4.8	113
E. MAIDENI	HCED	5.2	1.5	90.1 (6)	0.74	81	25.150	0.683	66.8	10.010	5.1	136
E. SALIGNA	HCED	5.7	1.5	89.1 (6)	0.70	77	19.910	0.760	78.1	11.450	4.4	123
E. CAMALDULENSIS	HCED	4.9	1.5	86.7 (6)	0.98	83	19.360	0.706	55.1	8.850	3.9	114
E. VIMINALIS	(C/D)EDED	5.4	2.1	92.0 (6)	-	76	18.810	0.740	52.4	7.970	4.2	105
E. RUDIS	(C/D)EDHD	4.9	2.1	88.5 (6)	-	81	16.670	0.745	46.4	6.920	4.5	70

(a) - 1 h. at 100° C (6) - ° GE (o) - ° SCAN

expected, NSSC pulp from unbarked logs is superior to the one from branches and tops.

HIGH YIELD KRAFT PULP FROM E. GLOBULUS: The experience on this type of cooking with progressive reduction of active alkaline and/or cooking temperature shows that:

It is easy to produce high yield kraft pulp from eucalyptus.

Rigidity is superior to the normal pulps available for fluting production.

Color can be controlled acting on alkali and temperature.

The pulp shows interesting possibilities for bleaching to obtain high resistance bleached pulps.

EUCALYPTUS FOR PAPER: Due to the differences in cooking conditions to obtain the best results, both pine and eucalyptus should be cooked separately. In this way the best pulp from the wood used is obtained, and it permits separate treatment of the fiber up to the paper machine.

All the papermaking experience in Cacia, where we have two separate fiber lines, was based on separate cooking of eucalyptus and pine pulps.

In our Viana unit, producing kraft linerboard, the continuous digester alternates in order to produce pulps with two different kappa numbers and, our experience with changes from pine to eucalyptus or vice-versa in our other continuous digesters, shows that no problem would arise from using the process here. However, for ease of operation, lack of storage capacity and relatively low percentage of eucalyptus wood used, we have been cooking there a mixture of chips of both species.

Eucalyptus is much easier to cook and bleach than pine and also requires different refining, which allows sizable savings in power and chemicals.

It was established years ago that kraft paper could be made with a considerable proportion of eucalyptus kraft pulp replacing the long-fiber pulp, and with no significant disadvantages.

Portucel's standard composition for sack kraft paper includes up to 40% kraft eucalyptus (e. Globulus), and the remainder kraft pine (pinus Pinaster).

We have two Jones 34", 600-hp, double-disc refiners with 5,5,6 (mm) discs, and four Jordan Majestic, 400-hp, 375-rpm, conical refiners, SS 3/8" bars. When making papers with high percentage of eucalyptus fiber, we usually refine it in the disc refiners, at about 4.5 consistency, avoiding too much load (never exceeding 6 hp day/ton on each pass). The mixed pulps are passed at about 3.5% consistency in the conical refiners, because when refining long and short fibers together, short fibers do not suffer appreciable shortening, particularly if the load applied on the refiners is low. This is also done to preserve the tearing strength of the long fiber, to compensate for the high percentage of eucalyptus pulp.

The pine pulp could, of course, be refined in the disc refiners, and the eucalyptus alone or mixed with the pine pulp in the conical refiners. However, by doing so we would not take advantage of the bonding capacity of eucalyptus fiber, which would then be useful only as a filler fiber. The tearing resistance of such paper would be very low, as would be its resistance to picking and high scuffing tendency.

Table 3

INTERPOLATED VALUES

	Interpolated Values at	Revolutions (Lampén) / Minutes (Valley)	Apparent Specific Volume, cm^3/g	Breaking Length, m	Stretch, %	Burst Factor, m^2/cm^2	Tear Factor, $m^2 \times 100$ (Elmmendorf)	Double Folds	Printing Opacity, %
Lampén	30 °SR	7 160	1.48	8 930	4.2	59.5	119	1 030	67
	45 °SR	14 100	1.40	9 950	4.7	70.4	116	2 400	65
Valley	30 °SR	2.5 min	1.82	4 710	2.5	27.1	94	16	74
	45 °SR	10 min	1.64	6 830	3.6	43.5	110	230	72

Lampén Beating: According to the Second Report of the Pulp Evaluation Committee of the B P. & B. M. A.

Valley Beating: TAPPI T - 200.

Sheet Making: TAPPI T - 205.

Testing Conditions: Temperature, 20 °C - Relative Humidity, 65%.

Table 4

Composition Pine/Eucal.	Subst. g/m2	Effective Beating Load (hp day/ton)			Air Res. Gurley	Burst Factor	Breaking Length m		Stretch %		Tear Factor Elmendorf		Ring Crush kgf		Puncture FEFCO	Dennison Pick Test	Steam Cons.
		Disc Ref.	Conic. Ref.	Total	s/100 ml	Mullen	L	T	L	T	L	T	L	T	Kgf/cm		t/t paper
85/15	70	9.3 (3)	5.5	14.8	19	47.0	8,200	4,800	2.8	6.3	113	120					3.0
85/15	70	3.8 (3)	7.1	10.9	20	50.0	9,400	4,900	2.4	5.2	116	125					3.0
60/40	70	5.8 (1) +5.8	6.6	11.2	14	44.8	8,300	5,100	2.7	5.6	123	135					2.7
50/50	70	4.3 (1) +4.3	5.4	9.7	19	46.8	9,200	4,900	2.5	4.9	118	128					2.7
75/25	125	6.7 (3)	4.0	10.7	33	52.0					116	129	11	6	5.5	18	3.0
70/30	125	2.2 (3)	7.4	9.6	38	47.5					123	135					2.9
50/50	125	3.9 (2)	9.5	11.5	43	49.4					108	114	12	6	4.5	21	2.8
85/15	180	-	11.0	11.0	13	41.0					187	200	13	9		18	2.9
60/40	180	5.6 (1) +5.6	6.1	10.6	18	40.7					183	226	15	11		18	2.8
75/25	200	3.3 (3)	7.0	10.3	14	43.0							23	18	8.3	18	2.8
50/50	200	3.6 (2)	9.3	11.1	31	42.1							19	17	7.9	18	2.6

1 - Eucalyptus pulp to 2 disc refiners in series

2 - Eucalyptus to 1 disc refiner

3 - P&E refined together

Table 5

RENOVA PM IV

TISSUE

COMPOSITION % E	P	WEIGHT gr/m2	ASH %	B. LENGTH L	T	HANDLE O. METER F1 SM	ST	F2 SM	ST	TOTAL	ABSORPTION KLEMM m/m	CREPE % (wet)
80	20	17	1.6	843	737	3.7	12.4	3.5	12.8	32.4	24.26	15.2
100	0	17	1.7	622	680	3.5	15.6	3.1	13.8	36.0	19.21	16.7
90	10	16	1.7	610	580	3.1	11.5	4.0	10.8	29.4	26.30	14.5
85	15	17	1.6	983	640	3.9	8.6	3.1	8.3	23.9	19.22	12.6

E - Eucalyptus Pulp

P - Pine Pulp

Table 4 shows figures obtained for various substances of kraft paper, using different percentages of eucalyptus kraft pulp. There is little difference in the paper characteristics when using up to 40% e. Globulus kraft pulp instead of pine.

The steam consumption drops with the increased use of eucalyptus pulp, by as much as 20% compared to 100% kraft pine pulp.

PAPER MILLS EXPERIENCE: For woodfree printing and writing paper, bleached eucalyptus pulp is used in percentages up to 85% in Portugal. This could be increased to 100% if the local paper mills were suitably equipped in the refining plant and on the paper machine. Paper machine improvements need to include the use of compact press sections with two or three nips before the first open draw to compensate for the lower wet web resistance of the eucalyptus fiber.

Eucalyptus pulp should be refined in a separate line, and refiners should be designed to prevent the cutting of the fibers and to promote wetting. Inapa, using slush pulp from the Setubal mill, employs wideangle type refiners with 13-mm-wide cast iron bars on the rotor, with the body lined with cast iron plates. The channels and perforations are 3-mm diam. and 20-mm-deep.

These perforations increase the total contact area, thereby reducing the specific load on the fibers and maintaining fiber length.

In Cacia mill, using unbleached pulp and disc refiners, a continuous adjustment of the refiner was necessary to avoid breaking of the fiber film which would have resulted in metal-to-metal contact. The advantages of using bleached sulfate eucalyptus pulp for printing and writings include: high whiteness, opacity, high bulk, good formation, high dimensional stability, good printability, and low energy use.

The high dimensional stability makes the paper ideal for computer use as well as for multicolor offset printing. Beside these advantages we can refer a a lower cost of fiber composition which can be mentioned, as well as the advantages resulting from the absence of resinous materials.

The disadvantages include: lower wet strength which can be overcome by a convenient design of the paper machine.

Refining problems due to the instability of the fiber film between the refiner bars.

Tendency to the formation of "fish-eyes".

Lower Dennison figures.

However, all this can be overcome, and the advantages far compensate for the drawbacks. Papers produced are of very good quality and well accepted by the market.

At Inapa the paper machine is going to be adapted to use a higher percentage of eucalyptus pulp. Additions include a new head box, press rearrangement and installation of an inclined size press, instead of the existing horizontal unit.

The experience of Renova, Fabrica de Papel do Almonda, deals with printings and writings as well as tissue. In some instances eucalyptus has been used up to 100%. When using 100% eucalyptus the decrease of the Dennison value is overcome by size-press treatment.

According to Renova, the use of eucalyptus pulp increases dryness after the presses, resulting in steam savings of 25-30%. An increase in dryness from 44-46% (with lower percentages of eucalyptus) to a maximum of 53.5% has been observed after the press part. This has permitted an increase of machine speeds.

Eucalyptus pulp has also been used in Renova for the manufacture of tissue paper, and Table 5 gives values related to tissue production on Renova's PM4. At present, tissue is normally made using 85% of eucalyptus pulp and 15% pine pulp.

PORTUGAL AS MARKET PULP SUPPLIER: The potential production of existing and planned mills producing bleached eucalyptus market pulp is as follows, in 1,000 tons/yr. The amount available for export is also shown.

YEAR	SULFATE		SULFITE	TOTAL	FOR EXPORT
	Existing mills	Former Celangol mill			
1979	483	-	83	566	480
1980	483	-	85	568	480
1981	483	-	90	573	475
1982	483	60	90	633	529
1983	483	100	90	673	563
1984	483	120	90	693	576
1985	483	140	90	713	600

Part of the production of the ex-Celangol mill will be bleached pine and is not included in the figures, neither is the production of other pulp grades made in the existing mills.

Eucalyptus pulp made by the sulfate, sulfite, NSSC, cold soda, chemi-mechanical and high-yield kraft processes have proved to be satisfactory.

With the rising cost of long-fibered coniferous pulp and the increase in fiber requirements, eucalyptus is a positive answer to the paper industry with its high productivity and short growing cycle together with the good aptitudes for papermaking.

Recent improvements in black liquor evaporation make possible 100% bark utilization and this adds more potential to the use of whole tree chipping techniques, and this increases the capacity of the forest.

The decrease in the use of energy, both in refining and in drying eucalyptus paper, is also an important advantage to bear in mind.

We at Portucel, having worked with eucalyptus for so many years, are well aware of its potentialities, and will continue to explore ways to improve both forest technology and pulp manufacture.

QUESTION: Could you please tell us the specific power and steam data in paper production?

ANSWER: I don't have accurate figures but I can tell you that due to increased dryness after the press section, the amount of steam for drying is less than with pine, by as much as 20 to 30%. The savings on power are mainly in the refining area because so much less refining is needed compared to pine. But I don't have the exact figure on power use. It must be on the average 20-30% less steam for making white papers with eucalyptus. Of course, when the machine is built for pine and then changed to eucalyptus, increased production can be obtained because drying capacity is higher.

QUESTION: You mentioned that for sack paper up to 40% pine could be replaced by eucalyptus fiber. Considering the differences in fiber length and also the general characteristics between two fibers, I wonder how the strength of the paper compares with 100% pine sack paper as is required in North America. Because we must admit there are different strength levels.

ANSWER: Yes, but it is different talking about sack paper in North America and Europe. When we say the paper made in Portugal has the same standards as in Eruope, we refer mainly to stretch values and also breaking length. With respect to the tearing strength, we also obtain about the same values but we don't work to tearing strength, and are not too much concerned with this property.

QUESTION: The best possible stiffness, that is obtained from neutral sulfite semi-chemical birch pulp for packaging. Considering the difference in characteristics between birch and eucalyptus how do these fibers compare in terms of Concora strength which is required in corrugating medium?

ANSWER: We have made experiments with neutral sulfite semi-chemical pulp, but only in the laboratory. We are producing fluting paper from eucalyptus in one mill using the soda process, but the laboratory results with the neutral sulfite semi-chemical which were made in 1970 show that the rigidity of the eucalyptus pulp from branches was better and comparable to the Scandinavian pulps. We did not study this in detail and the comparison was made with standard commercial NSSC paper available on the market.

QUESTION: I didn't understand clearly to what are you attributing the good Concora results with eucalyptus.

ANSWER: We assume that the morphology of fibers, relatively short with thick walls, together with easy delignification which results in less fiber damage, and more lignin present is responsible for that.