Table 1. Pulping conditions of *Citrus limon* branches

Cooking conditions Soda Soda-AQ1 Soda-AQ2 AS-AQ ASAM

Cook code CL1 CL2 CL3 CL4 CL5

Active alkali as NaOH, % 15 15 12 17 17

Anthraquinone, % - 0.05 0.05 0.05 0.05

Na2SO3 to NAOH ratio - - - 70:30 70:30

Liquor to *citrus Limon* branches 4 5 5 5 5

Maximum temperature, C0 170 170 170 170 175

Time to maximum temperature, min 60 60 60 70 70

Time at maximum temperature, min 120 120 120 120 120

Table 2. Physical properties of citrus Limon branches

Physical properties, % Limon branches

Average age of tree (years) 2

Moisture content 7.5

Basic density (oven dry) Kg m-3 572.1

Green density Kg m-3 577.3

Bark to wood ratio by volume 5.2

Bark to wood ratio by mass 6.7

Table 3. Chemical components of *Citrus Limon* branches from Khartoum State

Chemical composition, % Limon branches

Ash 3.5

Total Silica 1.1

Solubility in

Hot water 2.5

Cold water 3.0

Alcohol (Ethanol) 2.3

Ethanol: Cyclohexane (1:2) 1.0

1% NaOH 18.9

Kurchner-Hoffer cellulose 44.4

Alfa- cellulose 40.1

Pentosans 18.3

Lignin 25.1

Total Extractives 8.2

Cellulose to lignin ratio 1.8

Table 4. Pulping results and strength properties of *Citrus limon* branches

Cooking Conditions Soda Soda-AQ1 Soda-AQ2 AS-AQ ASAM

Cooking code CL1 CL2 CL3 CL4 CL5

Screened yield, % 41.9 56.0 59.7 55.4 60.1

Rejects, % 3 0.1 2 4.2 0.2

Total yield, % 44.9 56.1 59.7 59.6 60.3

Kappa number 26.3 21.9 22.8 20.7 19.5

**Strength properties**

Beating time, min

Tensile index, Nmg-1 0 0.4 1.4 1.5 1.7 2.6

10 1.1 2.1 2.8 3.1 4.1

15 2.8 3.2 3.3 4.1 4.5

Burst Index, Kpam2g-1 0 0.4 0.3 0.3 0.7 1.0

10 1.0 0.9 1.3 1.8 1.9

15 1.0 1.9 1.2 1.8 2.1

Grammage, Cm2 0 106 118.8 109 110 111

10 102 119.4 99.6 100 100

15 101.1 117.6 100 99.5 100

Thickness, mm 0 17.3 16.8 17.3 16.5 15.5

10 16.2 12.6 16.5 13.4 13.2

15 10.5 11.0 9.3 10 10