Effects of Wood Species and Log Diameter on Veneer Recovery

B. Kewilaa

Abstract

The total plywood production depends on veneer production due to log consumption. The ratio of veneer volume to log volume was stated as veneer recovery. The veneer recovery was affected by wood species and log diameter. Three wood species of *Shorea selanica, Terminalia catapa* and *Duabanga moluccana* were used in this experiment with four levels of log diameters. This experiment used the split block design and orthogonal polynomial analyses for equal space. The statistical analysis shows that wood species, log diameter and their interaction gave significance to highly significant effects on veneer recovery. The regression model for effect of log diameter (X) on veneer recovery (Y) by orthogonal polynomial analysis was Y = 34.373+ 0.429 X, with R^2 = 0.7366.

Key words: wood species, log diameter, veneer recovery.

Introduction

Forest industries were once regarded as the biggest contributor to the Indonesian economy (Prana *et al*. 2002). But that was not going on for long since it was soon realized that there was not enough raw materials to support the industries. The development of industrial timber plantations, which has been launched for a decade, could not save the industries from being collapsed. One of the major problems has been insufficient supply of raw materials. Recently many countries prefer to use woods from plantation forest rather than from natural forest due to the issues of decreasing the quality of global ecosystem.

Plywood, one of wood based panels, is produced from veneer. Veneers are manufactured from logs by a peeling process. Usually the veneer volume production is smaller than the logs volume; it is indicated as the percentage recovery. The recovery was affected by variation properties on wood species and log diameter. Wood species with higher specific gravity were more difficult to peel than species with lower specific gravity. It correlates to minimize the recovery (Kamil 1970). On the other hand wood species and logs diameter give significant affect on recovery (Sastrodiharjo 1977; Rachman and Karnasudirja 1978). It means that the bigger the diameter, the bigger the recovery (Rine 1952 in Kainama 1997).

The most important task of plywood producing industry is to estimate equivalent consumption of logs and main species being utilized (FAO 1966). Haygreen and Bowyer (1982) state that woods are grouped in four classes by stiffness and strength properties. Red meranti is grouped in the second class. For most plywood grades, the group is determined by the species of the face and back veneer. The inner veneer may be of a lower class.

Almost any species of wood can be peeled and converted to plywood (FAO 1966). Even so, the well-known principal wood species can give the biggest proportional contribution to the raw material requirement of plywood industry. The higher yield of veneer can be obtained from the good quality log (Haygreen and Bowyer 1982). FAO (1966) states, it is essential that before any species can be accepted for plywood veneer, that it should be peeled and sliced satisfactorily. Generally, most timber can be peeled satisfactorily and the veneer quality and percentage recovery are largely a matter of determining the proper manufacturing conditions consistent with characteristic of wood raw material. The range of timbers which can be successfully peeled are thus very large and cover a wide range of densities, from quite light timber to species that are heavier. Very low density wood can be difficult to peel except when the moisture content is high and the cell are filled with water; this gives mechanical support to the cell wall during cutting.

FAO (1966) states that log size and quality for plywood manufacture can vary widely from country to country depending upon whether the logs are required for local manufacture or for export. The minimum diameter requirements for plywood logs usually exceed those acceptable for sawn timber. Much, however, depends upon the natural limit of growth for specific timber species and whether logs are destined for local conversion or for export markets. The minimum diameter for most tropical species is usually about 0.45 m (FAO 1966). But Ackay *et al*. (2005) state that many forest stands in numerous underdeveloped countries are over stacked with small diameter trees. Avery (1975) states that for most hardwood species, veneer log must have a minimum diameter of 35 cm; preferred length range from 1.83 to 4.88 m, plus trim allowance. Rotary cut veneers are obtained from good quality logs. Output can be closely estimated from the difference between two cylinders, one based on the diameter of the veneer bolt at the small end and the other based on a presumed core diameter.

FAO (1966) states that logs for peeling from 1.0 to 1.9 m are obtained by crosscutting. Although a relatively low percentage recovery of the total log volume is obtained for veneer manufacture in this way, the logs are of very high grade and produce virtually all clear veneer. The quality of logs that are acceptable will vary according to the cost of the logs at the plywood mill. If this is high from a combination of stumpage, felling and transport charges, then only selected qualities can usually be accepted, because the percentage recovery of plywood from the log become very important.

In production process of raw materials to produce any product the industry must be able to reduce wastes and cost. The method to reduce these is a part of efficiency principles. So it is important for developing nations to establish an efficient wood supply system because they have a large population (Amano 2001).

Via and Shupe (2005) state that in the forest product industry, very rarely do manufacturers share production number with suppliers. As a result procurement managers find it difficult to forecast log quantity and species needed by local mills and instead have to react to immediate market and environmental conditions during harvest. Such independence between forest resources and manufacturing can be confounded for industry that produce a range of product from various species and make forecasting for log demand a challenging task (Kallio 2001 in Via and Shupe 2005). Being able to predict the number of logs a mill might process at the same time would be useful for forest managers in prioritizing which number of log to harvest, but this can only be done if manufacturers share products number with suppliers. Ackay *et al*. (2005) state that every mills have always wanted to maximize yield in order to reduce waste and increase profit.

The efficiency of log used could be predicted by log diameter minus log core. The size of log core diameter depends on rotary spindle head (Surachman 1979). The veneer volume is affected by log diameter (Sastrodiharjo 1977) and the percentage recovery is affected by wood species and log diameter (Rachman and Karnasudirja 1978). The Philippines Council for Agriculture and Resources research (1979) states that for Dipterocarps, veneer yield from rotary cutting has a linear relationship with the interaction of both diameter and percentage utility volume.

Average efficiency level of forest yield processed for wood conversion on plywood industry was between 45~55% (Apkindo 2000). The aim of log conversion by peeling is to obtain high yield and high quality in veneer production.

The total industry production of PT. Jati Dharma Indah Plywood Industry was 82,961.246 m^3 and plywood was 33,132.92 m^3 in 1995/1996 (Anonymous 2000). The total plywood production depends on the number of veneers that can be produced relatively to log consumption.

Shorea selanica, Terminalia catapa and *Duabanga moluccana* were selected because they are widely used at PT. Jati Dharma Indah Plywood Industry. Those species can be used to make veneer on data currently available, a list of wood species being used for veneer and plywood manufacturing (Martawijaya *et al*. 1981; Dumanauw dan Virsarany 1979; Nitihardjo 1985 and Sutisna *et al*. 1998). Large quantities of *Shorea spp* scatter in Seram, Buru, Obi, Sula and Halmahera Islands (Martawijaya *et al*. 1981) and *Duabanga moluccana* in the east region (Sutisna *et al*. 1998).

The specific gravity of *Shorea selanica* is between 0.39 ~ 0.52 (Martawijaya *et al*. 1981), *Terminalia catapa* is between 0.41 ~ 0.85 and *Duabanga moluccana* is between 0.27 ~ 0.51 (Dumanauw dan Virsarany 1979). Those species can be used for veneer making because the common range of air-dry density of plywood and veneer species is about 0.40 g/cm^3 to 0.70 g/cm^3 with preference for species about 0.50 g/cm^3 to 0.55 g/cm^3 (FAO 1966). A few species are used below the lower limit, but lower density wood has the disadvantage of being too soft for most uses (FAO 1966).

The purpose of this research is to know the effects of wood species and log diameter on veneer recovery and to fix regression model by orthogonal polynomial method on equal space (Steel and Torrie 1991) in order to estimate veneer recovery. The study specifically sought to determine if any unique variance in percentage recovery was explained by wood species and log diameters. The study emphasis was on recovery because many prior studies shown that recovery was influenced by wood species and log diameter (Kamil 1970; Sastradiharjo 1977; Rachman and Karnasudirja 1978; Kainama 1997). The overall goal of this study was to provide information that can be used by wood industry managers to predict the amount of veneer production due to the log consumption for plywood making.

Materials and Methods

Materials

Three wood species, *Shorea selanica, Terminalia catapa* and *Duabanga molucana,* were selected because they are mostly used in the Jati Dharma Indah Plywood Industry. A total of 36 pieces of fresh green logs 2.65 m in length with diameter between 50 ~ 89 cm, were brought to rotary lathe for peeling process.

Procedure

A total of 36 logs were brought to rotary lathe for peeling. Before peeling process the length and diameter of the logs were measured. The log volume was stated as input. The length, the width and the thickness of veneers were measured after peeling until veneer preparation process fixed the veneer output volume and stated them as output. The ratio of output to input was stated as the recovery. The woods raw materials as base data consist of 36 logs. The detailed steps of processing to collect data were:

1. To measure diameter and length of logs, those are important to fix the log volume as the volume input.
2. To peel the logs at rotary lathe: the logs are brought to rotary lathe for peeling process. The yield of peeling process were core random veneers, face/back veneers and center core veneers.
3. To dry: the yields of this process were face/back veneer, back random veneer and random core veneer.
4. To prepare: this step is the end of veneer processing. The veneers yield were produced include face veneers, back veneers and core veneers. Their volumes were stated as volume output to fix the percentage veneer recovery.

The data of that process were used to fix the volume of logs as an input factor, and the veneer volume as an output factor using the following formulas:

$V_{log} = 0.7854 \times l \times d^2$

$V_{vnr} = Q \times L \times W \times T$

Recovery = Output/input x 100%

Where:

V_{log} = log volume (m^3)
l = log length (m)
d = log diameter (m)
V_{vnr} = veneer volume (m^3)
Q = veneer quantity
L = veneer length
W = veneer width (m)
T = veneer thickness (m)

Data Analysis

The experiment consists of two factors. The A factor was species with three levels, i.e. *Shorea selanica* (a_1), *Terminalia catapa* (a_2) and *Duabanga moluccana* (a_3). The B factor was log diameter with four levels, i.e. 50 ~ 59 cm (b_1), 60 ~ 69 cm (b_2), 70 ~ 79 cm (b_3) and 80 ~ 89 cm (b_4) with three replications for each or 36 unit experiments.

This experiment used a split block design analysis to determine the difference between the treatment means and orthogonal polynomial analysis in order to find regression model (Steel and Torrie 1991). In this experiment, wood species and log diameter represented the whole plots, the plots of each factor physicaly cross one another. The research consists of 12 unit experiments with three replications or 36 unit experiments.

Results and Discussions

Results of experiment are given in Table 1. The experiment data showed that recoveries ranged from 51.40 ~ 69.74% and the average recovery was 60.23% (Table 1). Table 2 shows that the average recovery data of combination factors between *Shorea selanica* and 50 ~ 59 cm log diameter gives the lowest, and combination between the same species and 80 ~ 89 cm log diameter gives the highest percentage of recovery.

While the average recovery on species level *Shorea selanica* was the highest (61.62%) and *Duabanga moluccana* was the lowest (58.49%). And on the diameter levels, the 80 ~ 89 cm level is the highest (65.75%) and the 50 ~ 59 cm level is the lowest (54.53%) as shown in Table 2.

Statistical analysis shows that wood species and log diameter give highly significant effect and their interaction gives a significant effect on the recovery (Table 3).

Table 1. Veneer recovery as influenced by woods species and log diameters (percent).

Species	Log Diameter (cm)	Replication			Total	Average
		1	2	3		
Shorea selanica	50 ~ 59	51.40	56.12	53.38	160.90	61.62
	60 ~ 69	56.65	58.31	59.27	174.23	
	70 ~ 79	67.36	63.80	68.87	200.03	
	80 ~ 89	69.74	65.38	69.18	204.30	
Terminalia catapa	50 ~ 59	52.81	57.55	57.13	167.49	60.56
	60 ~ 69	58.95	57.91	58.06	174.92	
	70 ~ 79	62.99	61.21	62.72	186.92	
	80 ~ 89	64.49	66.56	66.43	197.48	
Duabanga moluccana	50 ~ 59	52.93	53.75	55.74	162.42	58.49
	60 ~ 69	56.27	57.32	57.63	176.22	
	70 ~ 79	59.63	60.54	58.13	178.30	
	80 ~ 89	60.92	63.78	65.28	189.98	
Total					2168.19	60.23

Table 2. The sub total of veneer recovery as influenced by wood species and log diameter.

Species	Log diameter (cm)				Total	Average
	50 ~ 59	60 ~ 69	70 ~ 79	80 ~ 89		
Sub total veneer recovery (%)						
Shorea selanica	160.90	174.23	200.03	204.30	739.46	61.62
Terminalia catapa	167.49	174.92	186.92	197.48	726.81	60.56
Duabanga moluccana	162.42	171.22	178.30	189.98	701.92	58.49
Sub total	490.81	520.37	565.25	591.76	2168.19	-----
Average	54.53	57.81	62.81	65.75	-----	60.23

Table 3. Analysis of variance

Source of Variation	Df	SS	MS	F_c	F_t	
					5%	1%
Block	2	13.06	6.53	2.03	3.89	6.93
Species (A)	2	60.80	30.40	27.39**	6.94	18.00
Error (a)	4	4.43	1.11			
Log diameter (B)	3	678.32	226.11	66.31**	4.76	9.78
Error (b)	6	20.44	3.41			
Int. AB	6	63.74	10.62	3.31*	3.00	4.82
Error (c)	12	38.53	3.21			
Total	35	879.32				

Notes: Df = degrees of freedom, SS = sum of squares, MS = mean square, Fc = f computed, Ft = f table
* = Significant, ** = Highly Significant

Table 4. The description of SS log diameter by orthogonal polynomial method

Effect	Diameter				Q	$r\Sigma Ci^2$	SS	Fc	F Table	
	50 cm up 490.81	60 cm up 520.37	70 cm up 565.25	80 cm up 591.76					5 %	1 %
l	- 3	- 1	+ 1	+ 3	347.73	9 (20)	671.76	197**	5.99	13.75
q	+ 1	- 1	- 1	+ 3	-3.05	9 (4)	0.26	< 1		
c	- 1	+ 3	- 3	+ 1	33.69	9 (20)	6.30	1.9		
							678.32			

Note : Q = Contrats = ΣCiYi ; ΣCi are given in appendix (Table 6) for each comparison
r = Equal space; SS = Sum Square ; Fc = Fcalculate

In that significant effect, the analysis can be continued by orthogonal polynomial analyses to fix the regression model. The result of orthogonal polynomial analysis is shown at Table 4, and then the regression model is:

$$\hat{Y} = \bar{y} + \beta_1 \lambda_1 \xi_1$$

$$= 60.23 + \frac{347.73}{9(20)} (2) \left[\frac{X - 60.23}{9}\right]$$

$$= 34.373 + 0.429 X \quad \ldots\ldots\ldots (1)$$

where :

$\hat{Y}$ = Veneer recovery prediction

$\bar{Y}$ = Aveage veneer recovery

b_1 = Coeficiet regressian

λ_1 are found in appendix (Table 6)

ξ_1 = orthogonal plynomial for equal spaced x's are defined by $\xi_1 = \frac{x_i - \bar{x}}{d}$

x = Log diameter

$\bar{x}$ = Average log diameter

d = Equal space

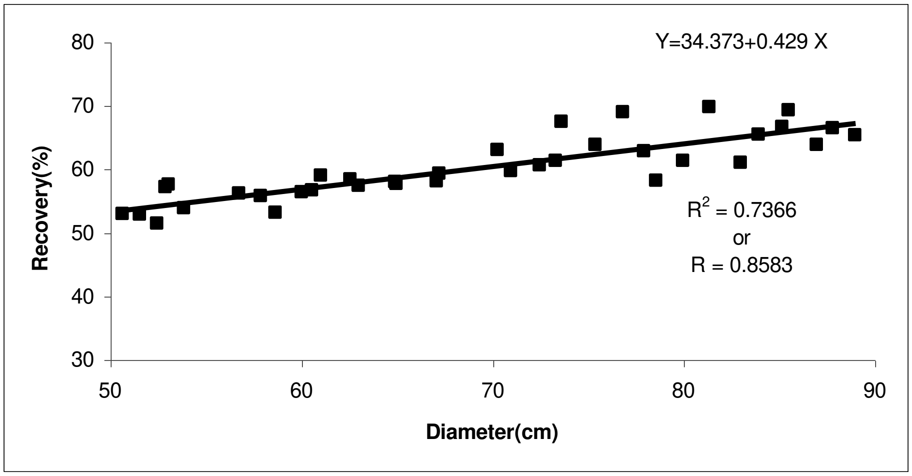

Figure 1. The relation between log diameters and veneer recoveries
Note: ■ = Recovery data

The equation above simply means that percentage veneer recovery increases at a rate of 0.429% per unit increases in the value of log diameter. Following equation (1), the effect of diameter to recovery is by increased veneer volume out put. The polynomial equation was fitted to the 36 data point (Appendix 1) comprising Figure 1.

Equation (1) shows the result of the curve-fitting process. The equations fit the data well with a coefficient of determination of 73.66% for veneer recovery value. It means that 73.66% of variation in a veneer recoveries variable is explained by diameter variable. The coefficient of non-determination is given by 1 - R^2 = 26.34%. It means that 26.34% is unexplained proportion of total sum of squares. Usually, it makes the bases of an error term. The slope of the curves increases after the veneer recovery passed 34.373%. The pattern corresponds to the experimental result obtained by Sastrodiharjo (1977); Rachman and Karnasudirja (1978); Kainama (1997), who also found out that there was an increase in recovery when the log diameter increased. When the data were analyzed, there were statistically significant differences between recoveries through variation in log diameters, species and their interaction.

The correlation analyses found that R = 0.858. It means that the diameter data have a strong correlate with recovery data. The correlation coefficient measures the closeness with which the regression line fits observed point. Thus the correlation coefficient measures the effect of independent variable (X) on the depended variable (Y). For R = 0.858 or R^2 = 0.7366 it means that 73.66% of the variation in a dependent variable (veneer recovery) is explained by independent variable (log diameter). The coefficient of nondetermination is given by 1- R^2 = 26.34. It means that 26.34% is unexplained proportion of total sum of squares, usually as the bases of an error term.

The result of this research can support the forest yield through a parcel of data, information and science in order to strengthen the planning and problem solving; therefore can contribute a rational way in applying yield method to solve the industry problem especially on veneer making. The prediction of veneer recovery by equation is shown at Appendix (Table 5).

Conclusions

1. Wood species and log diameter separately give a highly significant effect and their interaction gives a significant effect on veneer recovery.
2. The highest veneer recovery was shown by interaction effect of *Shorea selanica* and 80 ~ 89 cm log diameter.
3. The regression model by orthogonal polynomial analysis for the effect of log diameter (X) on veneer recovery (Y) is: Y = 34.373 + 0.429 X; R^2 = 0.7366

Suggestions

1. The model can be used to predict the percentage veneer recovery especially on *Shorea selanica, Terminalia catapa* and *Duabanga moluccana.*
2. It is necessary to search for more other wood species and factors to find a highly recovery in veneer manufacturing.

References

Ackay, H.; C. Eckelman and E. Hairarova. 2005. Withdrawal, Shear, and Bending Moment Capacities of Round Mortise and Tenon Timber Framing Point. Forest Products Journal 55(6): 60-67.

Amano, M. 2001. Trend of Forest Resources in the World and their Relations with Global Warming. Farming Japan 35 (1): 10-19.

Anonymous, 2000. Pengembangan Pengelolaan Beberapa Industri Hasil Hutan di Maluku. Laporan Penelitian Kanwil Departemen Kehutanan dan Perkebunan Kerjasama dengan Fakultas Pertanian Unpatti. Ambon.

Apkindo. 2000. Teknik dan Sistem Manajemen Jaminan Mutu Industri Kayu Lapis. Pusat Penelitian Hasil Hutan Pusdiklat Departemen Kehutanan dan Perkebunan Bogor.

Avery, T.E. 1975. Primary Wood Poducts. Natural Resources Measurements. Second Edition. New York, Aucland, Toronto. pp. 134-154.

Dumanauw, J. F dan T. Virsarany. 1979. Mengenal Sifat-sifat Kayu Indonesia dan Penggunaannya. PIKA. Semarang.

FAO. 1966. Plywood and Other Based Panel. Report of an International Consultation on Plywood and Other Wood-Based Panel Product. Rome. pp. 223.

Haygreen, J. G. and J. L. Bowyer. 1982. Forest Products and Wood Science. An Introduction. The Iowa State University Press/Ames.

Kainama, E. 1997. Pengaruh Kualita dan Diameter Dolog terhadap Rendemen Volume Finir pada PT. Artika Optima Inti. Skripsi Fakultas Pertanian Universitas Pattimura Ambon.

Kamil, R.N. 1970. Kayu Agathis sebagai Bahan Baku Kayu Lapis. Lembaga Penelitian Hasil Hutan No. 96. Bogor.

Martawijaya, A.; I. Kartasujana; K. Kadir and S.A. Prawira. 1981. Atlas Kayu Indonesia. Jilid I. Bogor.

Received : 09 Nopember 2005
Accepted : 25 April 2006
Final revision : 28 Mei 2007

B. Kewilaa
Fakultas Pertanian Universitas Pattimura
(*Faculty of Agriculture, Pattimura University*)
Jl. Achmad Yani, Batu Gajah, Ambon
Telp. 0911-315984

Appendix

Nitihardjo, S. 1985. Mengenal Tiga Puluh Jenis Kayu. Departemen Kehutanan, Direktorat Jenderal Pengusahaan Hutan.

Philippines Council for Agriculture and Resources Research. 1979. The Philippines Recomends for Dipterocarps. Veneer and Plywood. Los Banos, Laguna, Philippines.

Prana, M. S.; J. Kartasubrata; N.W. Soetjipto and A. Afandi. 2002. Alternative Species as Raw Materials for Wood-Based Industries in Indonesia. Proceedings of the Fourth International Wood Science Symposium. Serpong, Indonesia. pp. 283-286.

Rachman, O. dan Karnasudirja. 1978. Telaah Kasus tentang Limbah. Lembaga Penelitian hasil Hutan No. 121. Bogor.

Sastrodiharjo. 1977. Persyaratan Bahan Baku Logs dan Pengaruhnya Terhadap Rendemen Eksport Kayu Jati Gergajian. Proceedings Diskusi Umum. Manajemen Industri Penggergajian. Kelembagaan Penelitian Hasil Hutan Bogor. Indonesia Sawmill Association, Persatuan Sarjana Kehutanan Indonesia. Bogor.

Steel R.G.D dan J.H. Torrie. 1991. Prinsip dan Prosedur Statistika. Suatu Pendekatan Biometrika. Penerbit PT. Gramedia. Pustaka Utama, Jakarta.

Surachman. 1979. Penelitian Persentase Limbah Pabrik Kayu Lapis di Pontianak dan Kemungkinan Pemanfaatannya. Fakultas Pertanian Jurusan Kehutanan Universitas Tanjung Pura Afiliasi Fakultas Kehutanan IPB.

Sutisna, U; T. Kalima and Purnadjaja. 1998. Seri Manual. Pedoman Pengenalan Pohon Hutan di Indonesia. Prosea Network Office. Yayasan Prosea-Bogor.

Via, B.K. and T.F. Shupe. 2005. Relationship of Species and Season to Sawmill by Product Production. A Case Study. Forest Products Journal. 55(7/8): 35-41.

Table 5. The effect of diameter on veneer recovery.

No.	Wood Species	Log Diameter (cm)	Recovery data (%)	Fitted (%)
1.	*Shorea selanica*	52.48	51.40	56.88
2.	*Shorea selanica*	56.75	56.12	58.71
3.	*Shorea selanica*	58.66	53.12	59.53
4.	*Shorea selanica*	60.58	56.65	60.36
5.	*Shorea selanica*	62.60	58.31	61.22
6.	*Shorea selanica*	67.23	59.27	63.21
7.	*Shorea selanica*	73.64	67.36	65.96
8.	*Shorea selanica*	75.40	63.80	66.71
9.	*Shorea selanica*	76.85	68.87	67.34
10.	*Shorea selanica*	81.38	69.74	69.28
11.	*Shorea selanica*	83.95	65.38	62.42
12.	*Shorea selanica*	85.51	69.18	71.05
13.	*Terminalia catapa*	51.58	52.81	56.50
14.	*Terminalia catapa*	53.08	57.55	57.14
15.	*Terminalia catapa*	52.92	57.15	57.07
16.	*Terminalia catapa*	61.03	58.95	60.55
17.	*Terminalia catapa*	64.92	57.91	62.22
18.	*Terminalia catapa*	67.11	58.06	63.16
19.	*Terminalia catapa*	70.28	62.99	64.52
20.	*Terminalia catapa*	73.33	61.21	65.83
21.	*Terminalia catapa*	77.94	62.72	67.80
22.	*Terminalia catapa*	80.00	61.21	68.69
23.	*Terminalia catapa*	85.17	66.56	70.91
24.	*Terminalia catapa*	87.84	66.43	72.05
25.	*Duabanga moluccana*	50.66	52.93	56.10
26.	*Duabanga moluccana*	53.87	53.75	57.48
27.	*Duabanga moluccana*	57.91	55.74	59.21
28.	*Duabanga moluccana*	60.05	56.27	60.13
29.	*Duabanga moluccana*	63.03	57.32	61.41
30.	*Duabanga moluccana*	64.99	57.63	62.25
31.	*Duabanga moluccana*	71.00	59.63	64.83
32.	*Duabanga moluccana*	72.48	60.54	65.46
33.	*Duabanga moluccana*	78.58	58.13	68.08
34.	*Duabanga moluccana*	82.99	60.92	69.97
35.	*Duabanga moluccana*	87.00	63.78	71.69
36.	*Duabanga moluccana*	88.99	65.28	72.54

Table 6. Coefficients and divisors for orthogonal comparisons in regression: equally spaced treatments

Treatments	Degree of Polynomial	Treatment Totals T_1	T_2	T_3	T_4	T_5	T_6	Divisor $=\Sigma c_i^2$	λ
2	1	- 1	+ 1					2	2
3	1	- 1	0	+ 1				2	1
	2	+ 1	- 2	+ 1				6	3
4	1	- 3	- 1	+ 1	+ 3			20	2
	2	+ 1	- 1	- 1	+ 1			4	1
	3	- 1	+ 3	- 3	+ 1			20	10/3
5	1	- 2	- 1	0	+ 1	+ 2		10	1
	2	+ 2	- 1	- 2	- 1	+ 2		14	1
	3	- 1	+ 2	0	- 2	+ 1		10	5/6
	4	+ 1	- 4	+ 6	- 4	+ 1		70	35/12
6	1	- 5	- 3	- 1	+ 1	+ 3	+ 5	70	2
	2	+ 5	- 1	- 4	- 4	- 1	+ 5	84	3/2
	3	- 5	+ 7	+ 4	- 4	- 7	+ 5	180	5/3
	4	+ 1	- 3	+ 2	+ 2	- 3	+ 1	28	7/12
	5	- 1	+ 5	- 10	+ 10	- 5	+ 1	252	21/10

Source: Steel and Torrie (1991).