Survey of Wood Species Utilized for Roofing in South- Western Nigeria

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Abstract

A survey of the wood species utilized for house roofing in South Western Nigeria was carried out and a priority class developed for the wood species. Data were generated through the administration of structured questionnaire on 222 respondents randomly selected from Akure, Ado-Ekiti and Ibadan. Data were analysed using descriptive statistics and Friedman chi-square to compare the relationship of ranking pattern in the three cities at 5% probability level. 14, 11 and 16 wood species were listed in Akure, Ado-Ekiti and Ibadan as wood species utilized for roofing, while 21 were compiled from the lists of three cities. The preference for wood species varied among the three cities (χ^2 =75.03, df = 2, P<0.05). Piptadeniastrum africana, Pterygota macrocarpa and Celtis zenkeri were most preferred in Akure, Ado-Ekiti and Ibadan respectively with a rate of 82.12%, 89.11% and 89.91%. With the use of lesser used wood species (LUWS) for house roofing, it becomes imperative that the technical properties of these LUWS be studied and made available to users.

Keywords: wood species, roofing, preference rating

1.0 Introduction

Wood, the hard fibrous material that forms the main substance of the trunk or branches of a tree occupies a unique position as the world's most important raw material for construction purposes, since the earliest recognition that man could make use of the materials they found around them. Throughout history, wood and wood products have played a prominent role in window and door making, roofing, flooring and framing in building construction. In many parts of Europe and North America, wood and wood products of various types are used in whole building (walls and foundation inclusive) in residential, commercial and industrial buildings, farm dwellings and service buildings (Willenbrock *et al.*,1998).

The versatility of wood in roofing and in building construction generally is due to its characteristics which include: (i) the fact that wood is strong for its relatively lighter weight, thus enabling the fabrication of strong parts without incurring excessive weight (ii) the ease with which it can be worked into a variety of shapes and sizes of unique characteristics than other structural materials like iron and steel; (ii) the ease of being cut and worked with simple hand and machine tools, therefore lending itself to conversion both in the factory and on site; (iii) the ability to join satisfactorily with adhesives, nails, screws, belt and dowels; (iv) its being a poor conductor of heat thus maintaining stable heat with changes in temperature; (v) is beauty with variations in figure and colour blending when compared with other materials used in building construction such as steel and iron; (i) the fact that defects on wood can be detected by visual means without the use of microscope and the defects removed (Metterm,1986). The availability and abundance of wood from creation is also worthy of note as the earth contains about one trillion tonnes of wood, which grows at a rate of 10 billion tonnes per year. As an abundant, carbon-neutral renewable resource, woody materials have been of intense used in building construction and in 1991, approximately 3.5 billion cubic meters of wood were harvested worldwide for construction purposes (Horst *et al*, 2005).

The roof is usually the single largest surface area of a house and it has being defined as a framework on top of a building comprising of trusses on which a covering material is placed (Adesogan, 2013). It is one of the most important parts of a house to be considered for proper planning during building to ensure the material selected provides the best performance and visual effect.

Adesogan (2013) is of the opinion that while a house may be inhabited without some elements of buildings such as partition walls, beams or columns, a house without a roof is not conducive for human and even animal accommodation. Thus it deserves careful thought to prevent roof failures which according to Mijinyawa *et al.*, (2007) frequently manifest in Nigeria.

In Nigeria, wood is majorly used in roof construction; with the building industry alone consuming about 80% of the country's estimated 20 million cubic meters of annual lumber production (Lucas and Olorunnisola, 2002). History shows that few wood species such as *Khaya ivorensis* and *Milicia excelsa* are majorly used for roofing in Nigeria. However, these commonly used wood species (CUWS) are currently depleted in the forests due to over-exploitation. This is as a result of increased conversion of land for agriculture, excessive commercial logging, fires, and gathering of wood for fuel. Between 1976 and 1995, Nigeria's forest and woodland cover decreased considerably form 23million hectares to 15million hectares and by 1990, the country has lost close to 6.1 million ha or 35.7 percent of its forest covers (Simire, 2011). Consequently, greater proportion of the few CUWS that are brought to sawmill as far back as 1998 has been noted to be small diameter logs from which sub-standard planks are produced (Beak Consultants, 1998).

With the high depletion of the forest and a decline in the quality of the CUWS for roofing incessant roof failures have been reported in Nigeria (Mijinyawa *et al.*, 2007). This justifies the reason for research study on the wood species used for roofing in Nigeria. The study therefore finds it necessary to carry out a survey of the wood species used for roofing in South Western Nigeria while developing a priority class for the wood species. It is a preliminary study for further evaluation of wood species utilized for roofing in the study area.

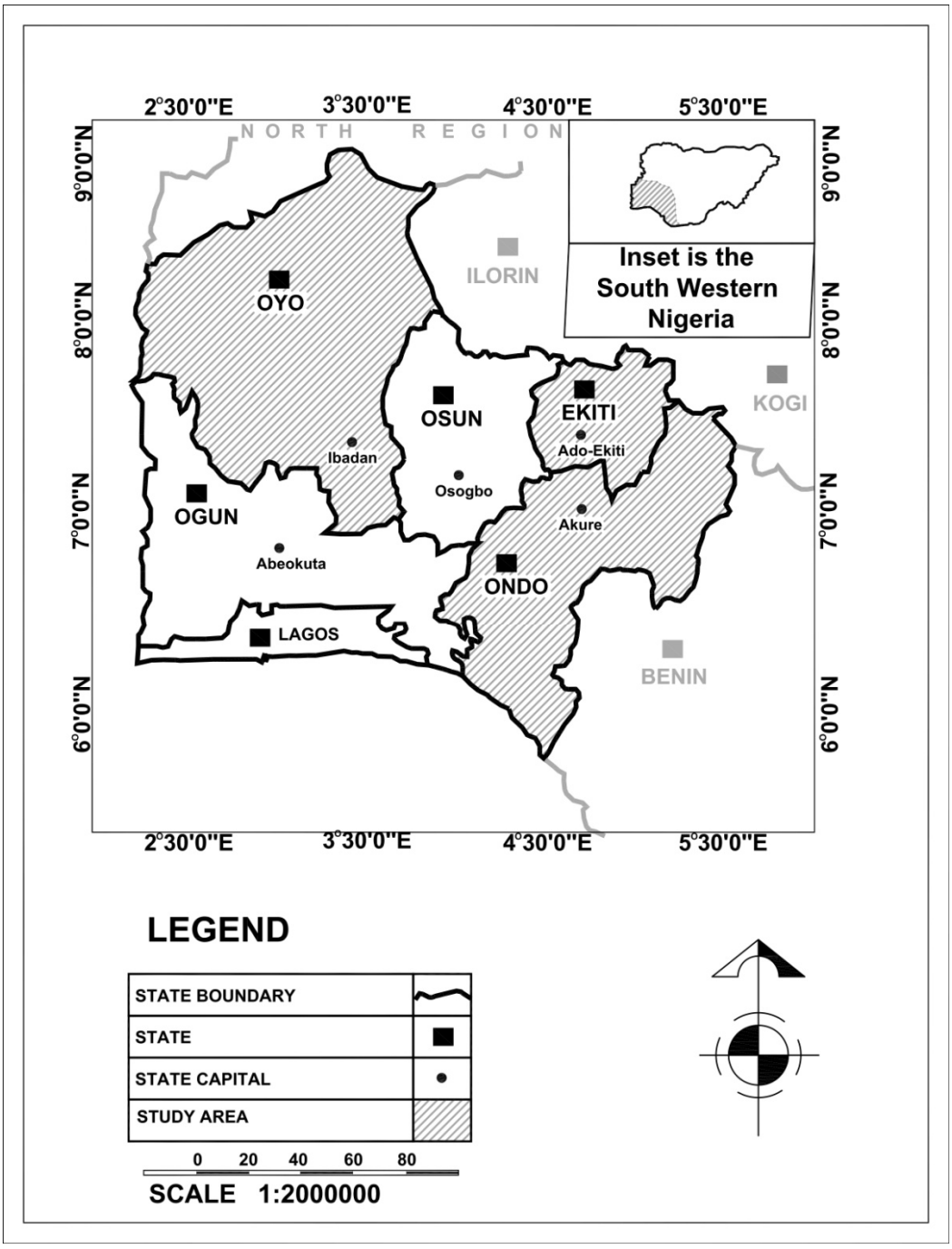
2.0 *Methodology*

2.1 Study Area

This study was carried out in Southwestern Nigeria comprising Oyo, Ogun, Lagos, Ekiti, Ondo and Osun states. The region is located in the rainforest zone where the bulk of the wood utilized in Nigeria for construction works are obtained. Southwestern Nigeria has a tropical climate with distinct wet and dry seasons. The wet and dry seasons last from April to October and November to March respectively with mean annual rainfall of between 1,000 to 3,000mm. Mean temperature ranges from 21°c to 31°c while humidity varies between 35-80%.

Ibadan, Ado-Ekiti and Akure, the capitals of Oyo, Ekiti and Ondo were randomly selected for the study (Figure 1). They are areas with high population of people belonging to the middle and high income groups with relatively decent buildings. Ibadan lies between latitude 7° and 23' North of the equator and longitude 3° and 55' East of Greenwich Meridian, a distance of about 145km North East of Lagos. It has a total land mass of 3.080km^2 and a population of 3.2 million (NPC, 2007). Akure lies on latitude 7° 15' North of the Equator and longitude 5° 11 east of the greenwhich meridian. It is about 250 metres above the sea level with a population of 588,000 (NPC, 2007). Ado-Ekiti is located between latitude 7° and 37' North of the equator and longitude 3° and 15' East of Greenwich Meridian. It has a population of 446,749 and a total land mass of about 884 km^2 (NPC, 2007).

Figure 1: Map of South Western Nigeria Showing the Study Area



Source: Geography Department, University of Ibadan, Nigeria

2.2 Sampling Technique

The targeted respondents for the study were carpenters who were involved in roof construction and wood planks traders involved in selling wood planks for roofing. 25% of the list of registered members of the associations of carpenters and planks sellers in Ibadan, Ado-Ekiti and Akure were randomly selected. Consequently, for carpenters, a total of 95 respondents comprising of 52, 15 and 28 carpenters were studied in Ibadan, Ado-Ekiti and Akure respectively. For wood plank sellers, 127 respondents comprising of 59, 30 and 38 wood plank sellers in Ibadan, Ado-Ekiti and Akure were studied. Thus a total of 222 respondents comprising of 111, 45 and 66 respondents were sampled in Ibadan, Ado-Ekiti and Akure respectively.

Structured questionnaire and interview were used to generate data on the wood species commonly utilized for roofing in the study area. The questionnaire was drawn up in such a way that the respondents listed all the wood species used for roofing and prioritised them in terms of how preferable they were used based on experience. The respondents listed the wood species in order of preference with the species in position number 1 being the most preferred and the last species listed being the least preferred.

2.3 Statistical Analysis

Data collected were collated and analysed using descriptive statistics of frequency, percentages and tables. The Friedman chi-square analysis was employed in comparing the ranking pattern of the prioritised species by the respondents to ascertain if there exists a relationship in the ranking pattern of respondents in the three cities. The analysis was carried out at 5% probability level. The statistical package used for the analysis was SPSS15®.

In order to compare the relationship of ranking pattern in the three cities, the analysis made use of the top ten priority cumulative ranking of the respondents in the three cities. Score point 10 was allocated to position number 1 (most preferred) on the ranking while score point 1 was allocated to position number 10 (least preferred) on the ranking in that order. The analysis of the ranking involved the summation of the product of the number of respondent for a particular wood species by the weight given and this was expressed as a percentage of the maximum score point. The maximum score point is the product of the number of respondents in the study area and the maximum point any wood species can have. The wood species with highest percentage score was considered to be the most preferred than those with lower percentage score. This method of allocation of values to ranking position as used by Arowosoge and Tee (2010) and adapted from Popoola and Galaudu (2000) is as follows:

Preference Ranking (PR): $\sum_{i=1}^{n} FS_i / nSM \times 100/1 \ldots\ldots\ldots\ldots\ldots Equation 1$

Where F = Frequency of respondents with the same score for wood species
Si =Allocated score for wood species and it ranges from 1 to 10 in this study
nSM = Product of the number of respondent interviewed and the maximum score point of a wood species.
n = Number of respondents interviewed

3.0 Results and Discussion

3.1 Wood Species Utilized for Roofing across the Study Area

From the lists of the wood species utilized for roofing in the three cities, a pooled list of 21 wood species were compiled across the study area as wood species utilized for roofing in the study area. The 21 wood species are indigenous and are presented alphabetically in their scientific names with species' authorities and according to their families in Table 1. The scientific names with species' authorities and the families of the wood species were compiled according to Keay (1989) and Gbile (2002). Only seven of the 21 wood species cut across the three cities. These findings show that few wood species are used for roofing in South Western, Nigeria, since the three cities studied are areas with relatively decent buildings. The 21 wood species identified constitute 3.5% of the total known 600 Nigerian forest tree species and 35% of the 60 marketable wood species in Nigeria. Beak Consultants (1999) gave the total known Nigerian forest tree species and the marketable wood species in Nigeria to be 600 and 60 respectively.

3.2 Preference Rating of Wood Species Utilized for Roofing in the Study Area

The wood species listed and rated for roofing in the three cities were 11, 14 and 16 for Ado-Ekiti, Akure and Ibadan respectively. The preference for wood species varied among the three cities (Tables 2, 3 and 4) and there was a significant difference (χ^2 =75.03, df = 2, P<0.05) in the preference rating in the three cities (Table 6). Fourteen of the wood species listed did not cut across the three cities. Also *Afzelia africana, Berlinia congolensis, Distemonanthus benthamianus, Entandrophragma candolei, Khaya senegalensis* and *Lophira alata* that were listed in Ibadan for roofing were not listed in Akure and Ado-Ekiti. The reason that could be adduced for the significant difference in the preference rating of wood species in the three cities as observed during the course of this study is that the CUWS for roofing are depleted in the forest. Consumers therefore used planks from trees that are matured and are available for roofing from their immediate environment. For example respondents in Ado-Ekiti and Akure were of the opinion that the popular wood species such as *Khaya ivorensis* and *Milicia excelsa* are of small diameter logs from which sub-standard planks of poor quality are produced.

Hence the preference for *Pterygota macrocarpa* and *Piptadeniastrum africana* that are matured and are more durable though they are regarded as lesser used wood species. *Pterygota macrocarpa* ranked 1st in Ado-Ekiti and 2nd in Akure while *Piptadeniastrum africana* ranked 1st in Akure and 2nd in Ado-Ekiti (Tables 2 and 3). *Piptadeniastrum africana* also ranked 2nd in Ibadan while *Pterygota macrocarpa* was not mentioned in Ibadan.

The utilization of these LUWS that are evolving agrees with the opinion of Jayaneth (1998) that several LUWS may not possess the aesthetic qualities of CUWS but nonetheless can meet the structural and functional requirement for use in construction. Poor quality of the CUWS has to do with reduced rotation age of trees, whereby young trees with small diameter are harvested. Young trees are known to contain high proportion of juvenile wood which are produced near the pith of trees. The juvenile wood are usually characterized by poor physical and anatomical properties, as a result of large proportion of high fibrillar angle, reaction wood, knots, and spiral grain which cause longitudinal shrinkage that may be more than 10 times that of mature wood and this in turn reduce their technical properties (Zobel and Sprague, 1998; Zobel, 2004; Wolfer and Murphy, 2005). The preference rating of pooled wood species across the three cities further confirmed a shift from the use of CUWS to LUWS with *Piptadeniastrum africana, Celtis zenkeri* and *Brachystegia kennedyi* ranking 1st, 2nd and 3rd with percentages of 82.66%, 78.74%, and 74.37% respectively (Table 5). The use of LUWS for roofing is a new trend and is contrarily to the findings of Arowosoge *et al.,* (2009) where few CUWS such as *Mansonia altissima, Khaya ivorensis* and *Cordia millenii* were preferred for furniture making in selected cities in Nigeria.

4. *Conclusion and Recommendation*

This study has shown that there is a new trend in the use of wood species for roofing in South Western, Nigeria. LUWS such as *Piptadeniastrum africana, Celtis zenkeri* and *Brachystegia kennedyi* are now preferred for roofing as against the CUWS of *Khaya ivorensis* and *Milicia excelsa* which are depleted from the forests and which respondents believe are of poor quality. The available CUWS are usually produced from small diameter logs of short rotation resulting in planks of poor qualities and thus a shift to the use of LUWS that are matured, durable and are readily available. Thus, LUWS were rated higher when compared with the CUWS in the study area. The utilization of the LUWS that are durable will reduce incessant roof failures in Nigeria and also reduce pressure on the depleted CUWS thereby allowing long rotation before harvesting.

Based on the findings of this study, it is therefore imperative that the technical properties of these LUWS be studied and made available to users. Technical manuals, design guidelines and codes of practice which could ensure the proper use of the LUWS and prevent faulty construction should also be made available.

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Table 1: Wood Species Utilized for Roofing Across the Study Area

S/N	Botanical names	Family
1.	*Afzelia africana* Sm	Fabaceae (Leguminosae)
2.	*Berlinia congolensis B*aker F.	Fabaceae (Leguminosae)
3.	*Brachystegia kennedyi* Hoyle	Fabaceae (Leguminosae)
4.	*Celtis zenkeri* Engel	Ulmaceae
5.	*Distemonanthus benthamianus* Baill	Fabaceae (Leguminosae)
6.	*Entandrophragma angolense* (Welw.) C.DC	Meliaceae
7.	*Entandrophragma candolei* Harms	Meliaceae
8.	*Entandrophragma cylindricum* Sprague	Meliaceae
9.	*Gossweilrodendron balsamiferum* (Verm.) Harms	Fabaceae (Leguminosae)
10.	*Khaya ivorensis* A. Chev	Meliaceae
11.	*Khaya senegalensis* (Desr.) A. Juss	Meliaceae
12.	*Lophira alata* Banks ex Gaertn. f.	Ochnaceae
13.	*Milicia excelsa* (Welw.) C.C. Berg	Rubiaceae
14.	*Mitragyna (Hallea) ciliata* Aubr**e**v	Moraceae
15.	*Nauclea diderrichii* De Wild.	Rubiaceae
16.	*Nesogordonia papaverifera* A Chev. Capuron	Sterculiaceae
17.	*Piptadeniastrum africana* Hook.f. (Brenan)	Fabaceae (Leguminosae)
18.	*Pterygota macrocarpa* K. Shum	Sterculiaceae
19.	*Sacoglotiss gabonensis* (Baill.Urb	Humiriaceae
20.	*Sterculia rhinopetala* K. Shum	Sterculiaceae
21	*Terminalia ivorensis* A. Chev	Combretaceae

Table 2: Preference Rating of Wood Species Utilized for Roofing in Ado –Ekiti

S/N	Wood Species	∑FS	nSM	PR (%)	Rating
1.	*Pterygota macrocarpa*	401	450(45)	89.11	1st
2.	*Piptadeniastrum africana*	398	450(45)	88.44	2nd
3.	*Brachystegia kennedyi*	345	450(45)	76.67	3rd
4.	*Celtis zenkeri*	324	450(45)	72.00	4th
5.	*Sterculia rhinopetala*	258	450(45)	57.33	5th
6.	*Khaya ivorensis*	234	450(45)	52.00	6th
7.	*Entandrophragma cylindricum*	224	450(45)	49.78	7th
8.	*Terminalia ivorensis*	216	450(45)	48.00	8th
9.	*Gossweilerodendron balsamiferun*	210	450(45)	46.67	9th
10.	*Entandrophragma angolense*	202	450(45)	44.89	10th
11.	*Milicia excelsa*	157	450(45)	34.89	11th

Note: Figures in brackets are the numbers (n) of people interviewed. ∑FS, nSM and PR are as earlier defined in equation 1 above.

Table 3: Preference Rating of Wood Species Utilized for Roofing in Akure

S/N	Wood Species	∑FS	nSM	PR (%)	Rating
1.	*Piptadeniastrum africana*	542	660(66)	82.12	1st
2.	*Pterygota macrocarpa*	537	660(66)	81.36	2nd
3.	*Celtis zenkeri*	426	660(66)	64.55	3rd
4.	*Nesogordonia papaverifera*	416	660(66)	63.03	4th
5.	*Brachystegia kennedyi Entandrophragma*	414	660(66)	62.73	5th
6.	*cylindricum*	405	660(66)	61.36	6th
7.	*Khaya ivorensis*	365	660(66)	55.30	7th
8.	*Milicia excelsa*	363	660(66)	55.00	8th
9.	*Sterculia rhinopetala*	305	660(66)	46.21	8th
10.	*Terminalia ivorensis*	297	660(66)	45.00	10th
11.	*Gossweilerodendron balsamiferun*	286	660(66)	43.33	11th
12.	*Nauclea diderrichii*	245	660(66)	37.12	12th
13.	*Mitragyna (Hallea) ciliata*	195	660(66)	29.55	13th
14.	*Sacoglotiss gabonensis*	103	660(66)	15.61	14th

Note: Figures in brackets are the numbers (n) of people interviewed. ∑FS, nSM and PR are as earlier defined in equation 1 above.

Table 4: Preference Rating of Wood Species Utilized for Roofing in Ibadan

S/N	Wood Species	∑FS	nSM	PR (%)	Rating
1.	*Celtis zenkeri*	998	1110(111)	89.91	1st
2.	*Piptadeniastrum africana*	895	1110(111)	80.63	2nd
3.	*Brachystegia kennedyi*	892	1110(111)	80.36	3rd
4.	*Milicia excelsa*	804	1110(111)	72.43	4th
5.	*Khaya ivorensis*	752	1110(111)	67.75	5th
6.	*Khaya senegalensis*	749	1110(111)	67.48	6th
7.	*Berlinia congolensis*	747	1110(111)	67.30	7th
8.	*Entandrophragma cylindricum*	742	1110(111)	66.85	8th
9.	*Mitragyna (Hallea) ciliata*	742	1110(111)	66.85	8th
10.	*Entandrophragma Candolei Terminalia*	638	1110(111)	57.48	10th
11.	*ivorensis*	524	1110(111)	47.21	11th
12.	*Afzelia africana*	522	1110(111)	47.03	12th
13.	*Distemonanthus benthamianus*	502	1110(111)	45.23	13th
14.	*Gossweilerodendron balsamiferun*	452	1110(111)	40.72	14th
15.	*Nauclea diderrichii*	356	1110(111)	32.07	15th
16.	*Lophira alata*	276	1110(111)	24.86	16th

Note: Figures in brackets are the numbers of people interviewed. ∑FS, nSM and PR are as earlier defined in equation 1 above.

Table 5: Preference Rating of Pooled Wood Species Utilized for Roofing Across the Three Cities

S/N	Wood Species	∑FS	nSM	PR (%)	Rating
1.	*Piptadeniastrum africana*	1835	2220(222)	82.66	1st
2.	*Celtis zenkeri*	1748	2220(222)	78.74	2nd
3.	*Brachystegia kennedyi*	1651	2220(222)	74.37	3rd
4.	*Khaya ivorensis*	1377	2220(222)	62.03	4th
5.	*Entandrophragma cylindricum*	1351	2220(222)	60.86	5th
6.	*Milicia excelsa*	1324	2220(222)	59.64	6th
7.	*Terminalia ivorensis*	1037	2220(222)	46.71	7th
8.	*Gossweilerodendron balsamiferun*	948	2220(222)	42.70	8th

Note: Figures in brackets are the numbers (n) of people interviewed. ∑FS, nSM and PR are as earlier defined in equation 1 above.

Table 6: Friedman Chi-Square (χ^2) result for Comparing the Ranking Pattern of Respondents in the Study area

Study Area	χ^2 Calculated	Critical value	df	Prob. Level
Ado-Ekiti, Akure and Ibadan	75.03	5.99*	2	P<0.005

* = Significant at 5% probability level