Articles

Woodworkers' Demographic Characteristics and Perceptions of Popular Wood Preservatives in the Ghanaian Housing Industry

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Abstract

In the housing industry in Ghana, wood treatment is often done using water-borne preservatives. Common examples of preservatives include Acid Copper Chromate (ACC), Chromated Copper Arsenate (CCA), and Chlorpyrifos (Dursban). It is important to know that good wood preservatives must be available on the market to ensure the quality of wood products in the Ghanaian housing industry. It is not enough that the preservative is efficient; it ought to be popular on the market. However, the popularity of a preservative may not necessarily portray its popularity. The main purpose of this study was to identify the most and least popular water-borne wood preservatives (Dursban, CCA, and ACC) in use and also determine any possible associations between woodworkers' views concerning the most and least popular water-borne wood preservatives used in the housing industries and demographic status. An analytic sample of 199 participants was included in our study using a cross-sectional descriptive survey design. The results suggest that woodworkers rated Dursban as the most popular (65 %), CCA least popular (52 %), and ACC unsure (37 %). More specifically, young adults (74 %), secondary educated (84 %), carpentry speciality (86 %), and over two years experienced (88 %) woodworkers rated Dursban the most popular water-borne wood preservative used in the housing industry. However, young adults (56 %), secondary educated (59 %), carpentry specialists (59 %), and over two years experienced woodworkers (60 %) rated CCA the least popular water-borne wood preservative use in the housing industry. Further, we observed significant associations between participants' education, profession, and experience with their perceptions of widespread water-borne wood preservatives used in the Ghanaian housing industry. Our study has implications for research, practice, and policy.

Keywords: demographic characteristics, Ghana, housing industry, perceptions, popular wood preservatives, woodworkers.

1. Introduction

In the housing industry in Ghana, wood treatment is often done either using tar oils (Creosote) or water-borne preservatives such as Acid copper chromate (ACC), Chromated Copper Arsenate (CCA), and Chlorpyrifos (Dursban). Woodworkers' enhanced utilisation of these types of water-borne wood preservatives has recently received much attention from professionals in wood

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science, wood treatment industries and do-it-yourself (DIY) wood treatment for the construction industry (Li et al., 2019). Oil-borne and water-borne preservatives were introduced in the companies since the 1830s to protect wood against insects, fungi and alteration from weathering. Preservatives help to extend the wood service time by 25 to 50 years (Coudert et al., 2013; Hill, 2007; McBain et al., 1995). Water-borne preservatives were introduced into the market in the 1950s. Their carrier often provides a clean surface on the treated wood (Schultz, Nicholas, 2004). Preserved wood with water-borne preservatives can be painted post-treatment and used for a wider range of applications, such as utility poles, residential lumber, and timber, as well as for the protection of wood composites (American Wood Protection Association, 2019). Despite the necessity of normal seasoning being required after treatment, good water-borne preservatives do not "bleed" when dried and are odourless and non-combustible (Everett, Barritt, 1994). Usually, they are greatly used for pressure impregnation, and deep penetration is obtained in permeable timbers. Good wood preservatives must be available for use. It is not enough that the product is efficient; it ought to be popular on the market. However, the popularity of a chemical may not necessarily portray its popularity; this study seeks to find out which of the water-borne wood preservatives in Ghana ACC, CCA and Dursban is most and least available on the market.

Acid Copper Chromate (ACC) is one of the copper compounds of wood preservatives frequently used (Jones et al., 2019). The ACC is a wood preservative only registered for industrial and commercial uses (Virani et al., 2021). It holds well when exposed to decay and termite attack and prevents corrosion (Lebow, 2010). It contains 31.8 % copper oxide and 68.2 % chromium trioxide (Lebow, 2003). Another common preservative is Chromated Copper Arsenate (CCA), which contains 47.5 % Hexavalent Chromium, 18.5 % copper, and 34 % inorganic arsenic (Chen, Olsen, 2016). According to them, in the 1970s, CCA was widely used in the US for outdoor residential wood such as decks, picnic tables, landscaping timbers, fencing, patios, walkways, boardwalks and playground structures until it was banned (Stilwell et al., 2003).

In the early years of the 20th century, the preservative most commonly used in building construction in the United States was CCA (Prestemon, 1914); the pressure-treated wood was then labelled to show the chemical retained and the appropriate use. For instance, Hopey (1998) reported that about 20-50 % of CCA can seep out of wood when it is improperly applied, which causes their imperfect "fixing". According to Ofori and Bamfo Jr (1994), CCA, the most widely used wood preservative in Ghana, is non-toxic to humans and animals because of its permanence in wood. For CCA, the hazard associated with arsenic and chromium are more acute before impregnation, as fixation results in forming insoluble complexes in wood (Eaton, Hale 1993). Dursban appears to be the most common wood preservative on the Ghanaian market nowadays. Chlorpyrifos, the active ingredient in Dursban, was considered moderately hazardous to humans by the World Health Organization (WHO) based on its acute toxicity (WHO, 2010). In agriculture, it was one of the most widely used organophosphate insecticides in the United States. Before it was phased out for residential use, it was one of the most used residential insecticides (Moore et al., 2014).

In this study, we explored the association between demographic characteristics and popular perceived water-borne wood preservative (ACC, CCA, and Dursban) usage. The perceived agreement level of widespread use of water-borne wood preservatives was measured among woodworkers with varied educational levels, major fields, and experience levels in the wood industries. We were interested in knowing from woodworkers' perspectives which water-borne wood preservatives were the most popularly used and determining how these water-borne wood preservatives were associated with the woodworkers' demographic groupings. By popularity, we operationalised as the chemical most liked, accepted, esteemed or patronised by many woodworkers as the most preferred for preservation.

2. Methods
Research Design
A cross-sectional study with a descriptive survey design was used.
Population and Sampling
The target population of this study consisted of all woodworkers in the Greater Accra Region of Ghana between June and July 2021. From this population, a total of 300 woodworkers were originally sampled for the study.

Instrument

The instrument comprised two main sections; socio-demographics and perceptions of the woodworkers on popular water-borne wood preservatives in Ghana. The socio-demographic characteristic items included questions on participants' age, education, profession, and experience. The section on woodworkers' perception consisted of 4 items measured on a 5-point Likert scale [5 = strongly agree, 4 = agree, 3 = undecided, 2 = disagree, and 1 = strongly disagree] to measure their views on each statement of popular water-borne wood preservative in use.

Data Collection and Procedures

The authors designed a self-reported questionnaire, and was piloted. The pilot study was conducted using a convenience sample of approximately 50 woodworkers from a different district in the region to establish the reliability coefficient for the items in the questionnaire. The pilot study's results helped ensure the survey items' clarity, phrasing, and sequencing. The main objective of the pilot study was to determine the reliability value based on Cronbach's alpha. The Cronbach's alpha value for the perceived popular water-borne wood preservative was 0.34. No item in the response scale score was reversed. After conveniently selecting 300 woodworkers, only 240 responses were retrieved, giving a response rate of 80 %.

Data Analysis and Procedures

For this study, these independent variables; age groups (teens (up to 20 years) and young adults (above 20 years), education (basic level, secondary level), profession (carpentry, building technology), and experience (less experienced (up to 2 years), more experienced (above two years), were used in the analyses. The dependent variable, perception of the popularity of water-borne wood preservatives in usage, was categorised as most popular, least popular, and unsure. Only woodworkers with fully completed the questionnaire were included in the analyses.

Cross-tabulation and Chi-square approaches were used through IBM SPSS Statistics 26. After cleaning the missing data values and non-response items, 41 of the 240 cases were excluded, and the remaining 199 cases were the sample size that could be described as a convenience sample. All 199 questionnaires were analysed.

Interpretive response scale. The 5-point response scale to each item was modified and collapsed into a 3-point response scale category, namely, most popular (1), least popular (2), and unsure (3). This modification was necessary to meet the rule of the Chi-square test that contingency s with more than 1 degree of freedom expected count of a cell should not be less than 5 (Meyers et al., 2013).

Interpretive scale of Cramer's V. In this study, Cramer's value for association was interpreted as follows. Weak association ranged from 0 to .24; moderate association ranged from .25 to .34; and strong association ranged from .35 to .60.

3. Results

Demographic Profiles

Table 1 provides frequencies and percentages of the demographic status of the woodworkers who participated in this study. The sample was dominated by male woodworkers (96 %), and the majority (59 %) of woodworkers were young adults. Approximately 56 % of the woodworkers had at least some secondary education, but 44 % had gone through basic school. About 51 % of the woodworkers were carpenters, and 49 % were building technologists. About 52 % of the woodworkers were more experienced, while 48 % were less experienced in the housing industry.

Table 1. Frequency/ Percentage Distribution of Woodworkers' Demographic Status (N = 199)

Status	Frequency	Percentage (%)
Gender		
Male	190	95.5
Female	9	4.5
Age		
Teen	82	41.2
Young adult	117	58.8

Education (Level)		
Basic	88	44.2
Secondary	111	55.8
Profession		
Carpentry	102	51.3
Building Technology	97	48.7
Experience (in years)		
<=2	95	47.7
>2	104	52.3

Woodworkers' Age and Perceptions of Popular Water-borne Wood Preservatives

To determine whether there was any association between age and perceptions of the most or least popular water-borne wood preservative used in the housing industry.

H0: There was no significant association between age and perceptions of the most or least popular water-borne wood preservative used in the housing industry.

H1: There was a significant association between age and perceptions of the most or least popular water-borne wood preservative used in the housing industry.

In this study, woodworkers were classified in two ways: by types of water-borne wood preservatives and by age groups. The results of cross-tabulation are shown in Table 2.

Table 2. Cross-Tabulation of Woodworkers' Perceptions of Most or Least Popular Water-borne Wood Preservatives and Age (n = 199)

Type	Teen			Young-Adult			Total		
	Most	Least	Unsure	Most	Least	Unsure	Most	Least	Unsure
Dursban	44(54)	24(29)	14(17)	86(74)	17(14)	14(12)	130(65)	41(21)	28(14)
CCA	20(25)	38(46)	24(29)	17(14)	65(56)	35(30)	37(19)	103(52)	59(29)
ACC	38(46)	17(21)	27(33)	33(28)	38(33)	46(39)	71(36)	55(27)	73(37)
Total	102(42)	79(32)	65(26)	136(39)	120(34)	95(27)	238(40)	199(33)	160(27)

Note: For age differences, the Chi-square test value for Dursban was $\chi^2 = 8.88$, p= .012, Cramer's V=.211; for CCA was $\chi^2 = 3.32$, p= .190, Cramer's V=.129; and for ACC was $\chi^2 = 7.39$, p= .025, Cramer's V=.193.

Tables 2, 3, and 5 showed cross-tabulations between demographic characteristics and perceptions of popular water-borne wood preservatives in use. The row percentages indicated that, out of 199 woodworkers, the proportion who rated water-borne wood preservatives used most popular ranged from 19 % of CCA to 65 % of Dursban and averaged 40 % across the sample. These results indicated that Dursban was the most popular water-borne wood preservative. However, the proportions that rated water-borne wood preservatives least popular ranged from 21 % of Dursban to 52 % of CCA, averaging 33 % across the sample. These results indicated that CCA was the least popular water-borne wood preservative. Furthermore, the proportions unsure of water-borne wood preservatives ranged from 14 % of Dursban to 37 % of ACC and averaged 27 % across the sample. These results indicated that woodworkers might not be familiar with ACC.

From Table 2, 54 % of teen woodworkers and 74 % of young adults rated Dursban most popular, but the difference between the two proportions was significant; Chi-square = 8.88, p = .012, Cramer's V =.211. This finding was not significant after conducting a Bonferroni adjustment. Conversely, 46 % of teen woodworkers and 56 % of young adult woodworkers rated CCA the least popular. The association between age and perceived popularity of CCA was not statistically significant; Chi-square = 3.32, p = .190, Cramer's V = .129. This finding indicated no significant association between age and perceptions of popular water-borne wood preservative use in the housing industry.

Education and Perception of Most or Least PopularWaterborne Wood Preservatives

To determine whether there was any association between education and perceptions of the most or least popular water-borne wood preservatives in the housing industries.

H0: There was no significant association between education and perceptions of the housing industries' most or least popular water-borne wood preservatives.

H1: There was a significant association between education and perceptions of the housing industries' most or least popular water-borne wood preservatives.

In this section, woodworkers were classified in two ways: by types of preservatives and by education levels. The results of cross-tabulation and Chi-square are shown in Table 3.

Table 3. Cross-Tabulation of Woodworkers' Perceptions of Most or Least Popular Water-borne Wood Preservatives and Education (n = 199)

	Basic			Second			Total		
Type	Most	Least	Unsure	Most	Least	Unsure	Most	Least	Unsure
Dursban	37(42)	30(34)	21(24)	93(84)	11(10)	7(6)	130(65)	41(21)	28(14)
CCA	29(33)	37(42)	22(25)	8(7)	66(59)	37(33)	37(19)	103(52)	59(29)
ACC	41(47)	14(16)	33(37)	30(27)	41(37)	40(36)	71(36)	55(27)	73(37)
Total	107(40)	81(31)	76(29)	131(39)	118(36)	84(25)	238(40)	199(33)	160(27)

Note: For education differences, the Chi-square test value for Dursban was $\chi^2 = 37.77$, p= .000, Cramer's V=.436; for CCA was $\chi^2 = 21.59$ p= .001, Cramer's V=.329; and for ACC was $\chi^2 = 13.15$, p= .001, Cramer's V=.257.

From Table 3, 42 % of woodworkers with basic education and 84 % of those with secondary education rated Dursban most popular, but the difference between the two proportions was significant; Chi-square = 37.77, p = .000, Cramer's V = .436. This remained significant after Bonferroni's corrections. This result indicated a statistically significant association between education and perceptions of Dursban as the most popular water-borne wood preservative and that the association appeared strong. However, 42 % of woodworkers with basic education and 59 % of those with secondary education rated CCA the least popular. The association between education and the perceived popularity of CCA was statistically significant; Chi-square = 21.59, p = .000, Cramer's V = .329. This finding indicated a significant association between education and perceptions of CCA being the least popular water-borne wood preservative and that the association appeared moderate. Thus, a significant and strong association existed between education and perceptions of popular water-borne wood preservative use in the housing industry.

Profession and Perception of Water-borne Wood Preservatives

To determine whether there was any association between profession and perceptions of the most or least popular water-borne wood preservative in the housing industry.

H0: There was no significant association between profession and perceptions of the most or least popular water-borne wood preservatives in the housing industries.

H1: There was a significant association between profession and perceptions of the most or least popular water-borne wood preservatives in the housing industries.

In this study, woodworkers were classified into two ways: by types of preservatives and by profession. The results of cross-tabulation are shown in Table 4.

From Table 4, 86 % of carpentry woodworkers and 43 % of those of building technology speciality rated Dursban most popular, but the difference between the two proportions was significant; Chi-square = 40.56, p = .001, Cramer's V = .451. This remained significant after Bonferroni corrections were conducted. This result indicated a statistically significant association between profession and perceptions of Dursban being the most popular water-borne wood preservative and that the association appeared strong. However, 59 % of carpentry woodworkers and 44% of those of building technology speciality rated CCA as the least popular. The association between profession and perceived (least)popularity of CCA was statistically significant; Chi-square = 30.33, p= .000, Cramer's V = .390. This finding indicated a significant association between profession and perceptions of CCA being the least popular water-borne wood preservative and that

the association appeared to be strong. Thus, a significant and strong association existed between profession and perceptions of popular water-borne wood preservative use in the housing industry.

Table 4. Cross-Tabulation of Woodworkers' Perceptions of Most or Least PopularWater-Borne Wood Preservatives and Profession (n = 199)

	Carpentry			Build Technology			Total		
Type	**Most**	**Least**	**Unsure**	**Most**	**Least**	**Unsure**	**Most**	**Least**	**Unsure**
Dursban	88(86)	8(8)	6(6)	42(43)	33(34)	22(23)	130(65)	41(21)	28(14)
CCA	4(4)	60(59)	38(37)	33(34)	43(44)	21(22)	37(19)	103(52)	59(29)
ACC	24(24)	36(35)	42(41)	47(48)	19(20)	31(32)	71(36)	55(27)	73(37)
Total	116(38)	104(34)	86(28)	122(42)	95(33)	74(25)	238(40)	199(33)	160(27)

Note: For professional differences, the Chi-square test value for Dursban was $\chi^2 = 40.56$, p= .000, Cramer's V=.451; for CCA was $\chi^2 = 30.33$, p= .001, Cramer's V=.390; and for ACC was $\chi^2 = 14.25$, p= .001, Cramer's V=.268.

Experience and Perception of Most or Least Popular Water-borne Wood Preservatives.
To determine whether there was any association between experience and perceptions of the most or least popular water-borne wood preservative in the housing industries.
H0: There was no significant association between experience and perceptions of the housing industry's most or least popular water-borne wood preservatives.
H1: There was a significant association between experience and perceptions of the housing industry's most or least popular water-borne wood preservatives.
In this study, woodworkers were classified in two ways: by types of preservatives and by number of years of experience. The results of cross-tabulation are shown in Table 5.

Table 5. Cross-Tabulation of Woodworkers' Perceptions of Most or Least Popular Water-borne Wood Preservatives and Experience (n = 199)

	<=2			>2			Total		
Type	**Most**	**Least**	**Unsure**	**Most**	**Least**	**Unsure**	**Most**	**Least**	**Unsure**
Dursban	39(41)	33(35)	23(24)	91(87)	8(8)	5(5)	130(65)	41(21)	28(14)
CCA	31(33)	41(43)	23(24)	6(6)	62(60)	36(34)	37(19)	103(52)	59(29)
ACC	47(49)	16(17)	32(34)	24(23)	39(38)	41(39)	71(36)	55(27)	73(37)
Total	117(41)	90(32)	78(27)	121(39)	109(35)	82(26)	238(40)	199(33)	160(27)

Note: For experience differences, the Chi-square test value for Dursban was$\chi^2 = 47.31$, p= .001, Cramer's V=.488; for CCA was $\chi^2 = 23.68$, p= .001, Cramer's V=.345; and for ACC was $\chi^2 = 17.81$, p= .000, Cramer's V=.299.

From Table 5, 41 % of woodworkers with at most two years experience and 87 % of those with over two years experience rated Dursban most popular, but the difference between the two proportions was significant; Chi-square = 47.31, p = .001, Cramer's V = .488. This remained significant after Bonferroni corrections. This result indicated a statistically significant association between experience and perceptions of water-borne wood preservative use, and the association appeared to be strong. However, 43 % of woodworkers with at most two years of experience and 60 % of those with over two years of experience rated CCA as the least popular. This result indicated that proportionately more over two years experience, woodworkers rated CCA the least popular than those at most two-year experience. The association between experience and perceived popularity of CCA was statistically significant; Chi-square = 23.68, p = .001, Cramer's V = .345. These findings revealed a significant association between experience and perceptions of CCA being the least popular water-borne wood preservative used and that this association appeared to be strong. Thus, there was a significant and strong association between experience and perceptions of popular water-borne wood preservative use in the housing industry.

4. Discussion

In this study, we explored the associations between the demographic status and the perceptions of woodworkers concerning the popularity of water-borne wood preservatives (ACC, CCA, and Dursban). Findings indicated that the woodworkers in Accra generally rated Dursban as the most popular water-borne wood preservative, and CCA is the least popular. Nearly 54 % of teen woodworkers and 74 % of young adults rated Dursban most popular. Furthermore, 42 % of woodworkers with basic education and about 84 % of those with secondary education rated Dursban most popular. About 86 % of carpentry woodworkers and 43 % of those of building technology speciality rated Dursban most popular. In comparison, 41 % of woodworkers with at most two years of experience and almost 88 % of those with over two years of experience also rated Dursban as the most popular preservative.

The popularity of Dursban use among the younger adult population, those with secondary education, carpentry woodworkers, and woodworkers with over two years of experience could be linked purely to its effectiveness. For example, a study by Mensah et al. (2022) clearly showed that Dursban is popular in Ghana and is effective as a chemical preservative for oil palm lumber. Although little evidence exists regarding these different choices and perceptions, it is interesting that about 57 % of the highly skilled building technology specialists did not see it as the most popular chemical option. This finding may not be surprising as Dursban has been identified in some studies as being toxic to human health, although effective as an insecticide (Hachemaoui et al., 2019; WHO, 2010).

Our study also noted that for the selected woodworkers who participated in our research, CCA is Ghana's least popular wood preservative. Results from our study showed that 42 % of woodworkers with basic education and about 59 % of those with secondary education rated CCA the least popular. Nearly 59 % of carpentry woodworkers and 44 % of those of building technology speciality rated CCA as the least popular. Almost 43 % of woodworkers with at most two years of experience and about 60 % of those with over two years of experience rated CCA the least popular. However, this perception conflicts with the findings of Ofori and Bamfo (1994), which indicated CCA as the most widely used wood preservative in Ghana. Recent studies on CCA have shown that most countries prohibit using this chemical preservative because of its associated environmental and human health problems (Morais et al., 2021).

5. Conclusion and Recommendations

We conducted a cross-sectional study among a convenience sample of 199 woodworkers. Overall, woodworkers rated Dursban most popular, CCA least popular, and ACC unsure. More specifically, young adults, secondary educated, carpentry speciality, and over two years of experienced woodworkers rated Dursban as the most popular water-borne wood preservative used in the housing industry. However, young adults, secondary educated, carpentry specialists, and over two years experienced woodworkers rated CCA as the least popular water-borne wood preservative used in the housing industry. There is no significant association between age and perceptions of popular water-borne wood preservative use in the housing industry, which seems contradictory. However, the other findings underscore the anticipated results, which portray significant and strong associations between education, profession, and experience with their perceptions of popular water-borne wood preservative use in the housing industry. Manufacturers must produce more environmentally friendly water-borne wood preservatives that can substitute CCA and ACC wood preservatives that have been banned in some advanced countries and are not being produced enough for the users. The authors recommend researching oil-born and water-borne preservatives to ascertain which is more popular.

6. Funding

7. Acknowledgements

8. Conflict of Interest Statement

There is no conflict of interest to declare by the authors.

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