3.A Developing Model of Utilizing and Producing

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A Developing Model of Utilizing and Producing Galam (*Melaleucaleucadendron*) as A Natural Wood Preservative

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ABSTRACT

This research aims to get both the active chemical compounds of *galam's* wood vinegar which functions as antifungi and anti-termite usage and the process or factors influence it. Another purpose of the research is to find how effective the active compounds are toward wood destroyer organisms, either termite or fungus. Anti-termite assay is done by using a method of the mortal percentage of termites in sort of *Cryptotermes cynocephalus* Light and a method of growth inhibition of *Schizopyllum commune* fungus by wood vinegar for antifungi assay. To find the influence within the treatment of wood vinegar production process (the raw material condition and distillation), wood vinegar concentration level concerning with the active compounds of antifungi and anti-termite, each of treatments is analyzed using statistical analysis with CRD. Wood vinegar is a natural organic liquid resulting from the condensation of smoke in the process of making charcoal. Generally, the result shows that galam's wood vinegar have a potential used as natural wood preservative material. For this kind of utility, the vinegar can either be spontaneously used or be reproduced by a distillation process with 50% concentration. Galam's wood vinegar contains some components, namely phenolic, acid and carbonyl.

Key words: Wood vinegar, galam, anti-termite, fungicide

INTRODUCTION

For South Kalimantan people, galam charcoal (*Melaleuca cajuputi*) has been well-knownand produced by several charcoal industry developers such as the charcoal industry in Tanah Laut Regency. This region is one of industrial centers of wood charcoal in South Kalimantan. Not less than 400 charcoal industries exist here, spread in three districts,Takisung, Jorong, and Bati-Bati. The production processes of charcoal often result in smoke spread freely to cause much air pollution. We can imagine how dangerous and damaging it is since the burning process usually takes three weeks for once carbonization, then the gas resulted can reach 70 to 80 % of the once charcoal making process.

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However, the gas can be proceeded to be some wood vinegar through a simple modification of the instruments used without influencing the result or quality of charcoal itself. In the several regions, there have been many studies on wood vinegar and its advantages. In rural of Thailand, people usually made charcoal from branches or pieces of wood by earthen Kiln. They use these charcoals as fuel for cooking. Consequently, kiln always generated harmful and polluted gasses into the village. Recently, various style of kiln was introduced to public but no supporting documents and information Wood vinegar has been traditionally used as fungicide, sterilizing agent, deodorizer, antimicrobial, fertilizer, growth promoting agent, antioxidant, and coagulating agent (Chalermsan & Peerapan 2009), (Manu & Sangsrichan 2009), Baimark *et al*. 2008).

Nevertheless, there has not been single study that specifically promotes wood vinegar in *galam*. The affectivity assay as the preservative material as anti-termite

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Cryptotermescycochepalus Light and antifungi *Schizopyllumcommune* is also less known. Both organisms are known as the woods destroyers. Besides that, it is also still uncommon to research vary of factors that influence the chemical compound of galam's wood vinegar. By doing so, this research will aim to obtain appropriate and effective production technique and formula in making galam's wood vinegar as a natural wood preservative. In accordance with the fact above, it is necessary to make a set of study about developing product utilization of galam wood vinegar and its effectiveness as a natural wood preservative.

MATERIALS AND METHODS

Materials

The materials used in this study is *galam* wood, termite *C. cynocephalus* Light, fungi *S. commune*, rubber wood, Potato Dextrose Agar, Aquadest.

The instruments work with this study are modified kiln, bottles made of glass, glasses, a set of fungi assay tools, analytic balance, and a set of GCMS and distillatory.

Wood Vinegar Production

Galam's wood vinegar is produced by using modified kiln (Fiq 1). Some galams are put into the kiln fully. Then, the fireplace is shut. A pipe line for liquid gas drainage is set on the fireplace lid. The cooking process takes about ten hours. The vinegar resulted is loaded into a glass bottle.

The next step is to make distillation in the wood vinegar using modified Ratanapisit *et al*. 2009 method. The wood vinegar produced is distillated in the thermal degree of 100^0C for around six hours. This process will separate the wood vinegar content based on its temperature. Every type of the vinegar resulted is going to be analyzed for its smell and color level helped by 100 respondents.

(a) (b)

Figure 1. Traditional Kiln (a) and Drum Klin with Pipe Line (b)

Anti-Termite Assay

The assay is done with modified method done by Rudi *et al* 1999. The assay sample used is rubber wood gathered from a sawing industry in Banjarbaru. The sample was taken randomly and soaked in the wood vinegar with concentration level of 0, 25, 50,75 and 100% toward aquadest. It was put into some plastic glasses together with fifty dried wood termites (forty-five worker class termites, and five soldier class termites) in each glass. Then, the glasses were closed with gauze fabrics. After that, they were stored in the dry box or put in the dark room and controlled every three days for three weeks. In the three-week-observation, the researcher made a termite's mortality grade and weight sample decrease percentage. The mortality of dry wood termites was stated with a comparison

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between the numbers of the death termites and the total termites sample used in the assay and stated in percents.

Antifungi Assay

Antifungi assay is carried out with growth inhibition method of *S. commune* by *in-vivo*. Fungi isolate is put into centre of a petri disc which has been filled with media of PDA and galam's wood vinegar with concentration level 0, 25, 50, 75 and 100% toward aquadest. The growth inhibition measurement is by measuring the fungi growth diameter that is observed until the 10^{th} days (Philip 1994).

Chemical Compound Analysis

The chemical compound of galam's wood vinegar is analyzed by using GCMS (Silverstein *et al* 1991). The analysis is held on with high temperature, 325^0C. The column used is HP-5MS capillary column with 30m length and 0,25 um for its diameter. It also uses split injection and drainage system is with a pressure in 7,5 psi and 49,6mL/s speed.

RESULT AND DISCUSSION

Wood Vinegar Production

Wood vinegar has been succeeded to produce with *galams* as the main material. The incision process of wood vinegar is distillated then and it is produced different wood vinegar from the early one. The result is signed as crude wood vinegar, distillated wood vinegar and residue of distillated wood vinegar (Fiq.2). In accordance with the questionnaires distributed to 100 respondents, it is found that distillation process can result in very pure wood vinegar. The data gathered from 100 interviewed respondents dominantly stated that the crude wood vinegar (without distillation) smelt sharp; it smelt less sharp for residue of distillated wood vinegar; whereas the wood vinegar processed by a distillation smelt very sharp.

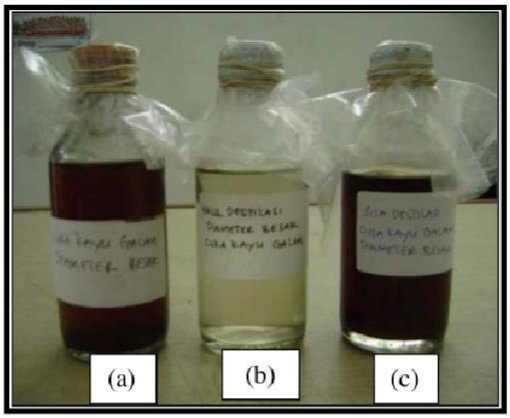

Figure 2. The wood vinegar product through distillation process; a : The crude wood vinegar / before distillation; b : The distillated wood vinegar; c. residue of distillatedwood vinegar

Commonly, most of the respondents said that distillated wood vinegar had pure colour, even though its smell was sharp. The pure colour vinegar resulted through the distillation process is caused by a purifying process. By doing so, the carbonyl tied up within the rook in the vinegar will reduce. According to the identification by some respondents, the genuine colour of wood vinegar is brown but the distillation residue is dark brown. The result of wood vinegar distillation process is shown in figure 2. Carbonyl has most effect on forming brown colour in fumigation product. The carbonyl components which have the most rolesare aldehid glyoxalin and metal glyoxalin, whereas formaldehyde

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hydroxiacetol are part less. Phenol is, on the other hand, has an important role to result brown colour in the fumigated product even though it is not as intensive as carbonyl. Wood vinegar consists of three kinds; they are wood vinegar grade 1, grade 2, and grade 3. Wood vinegar grade 1 is a production process with continuation distillation so that the amount of carbon in the condensed gas will be eliminated. The result is better with purer yellow. It functions as a food preservative such as for meatballs and noodles. Moreover, grade 2 is a processing with repetitive distillation to eliminate the amount saturated carbon in the condensed smoke. Its colour is red. It is used as an alternative material of formalin with natural and herbal content. Grade 3 is a processing with a little distillation for carbon elimination in the condensed smoke. This is for rubber wood preservative and smell remover (Sholeh 2009).

The quality of liquid gas is also determined by the purity of compounds within. The compounds are not completely appropriate to the usage of liquid gas as anti-microbes, antioxidant, bio-insecticide, and so on. The other compounds such as alcohol, aldehid, ketene, organic acid including furfural, formaldehyde, are the well-known preservatives, but phenol, quinol, quicol, and pirogalol are parts of antioxidant and antiseptic compounds. Therefore, purifying is very necessary to do to separate the compounds so that it can produce the component of expected liquid gas as a preservative.

Wood vinegar is produced from wood burning in airless condition namely Iwate kiln. It is applied for agricultural use in several purposes including pest control, improving soil fertility, plant growth accelerating substances, plant growth regulator, or growth inhibiting. It can be used for organic agriculture. However, the wood vinegar must be through a purifying process and diluting water before use. Therefore, the volumes is very important for considering, also appropriate plants are determined. However, the wood vinegar is new organic substance and great benefit to concept of organic agriculture, also need to do much more research in the future. (Pangnakorn 2008).

Potential of galam's wood vinegar as Anti-Termites

Mortality

The data of the assay proves that from the combined 50 % treatment concentration of crude wood vinegar and other 50 % with a distillation process are the optimum treatments to press the amount of termites attack because in accordance with the statistical analysis, the average mortality of dry-wood- termites has reached 100%. According to the fact above, it can be stated that the treatments combination is a save minimum concentration to avoid rubber woods from the termites attacks.

The higher the mortality average of the dry-wood-termites followed by the higher wood vinegar concentrate caused by the thicker preservative substances, the more preservative contents of wood vinegar covering the rubber wood's surface. Therefore, the woods will be poisonous and destructive for dry-wood-termites, so that there will more numerous killed termites because of the strongly bad aroma from the herbal preservative. Phenolic acid content and high allow to be developed as a wood preservative , given the phenolic compounds having acut toxicity (Petrochemical 2008). Termites are much desired to destroy the wood if it is not protected by poisonous chemistry. On the other sides, termites' taste toward the woods is decreasing and their mortality rate is increasing if the woods have higher and higher poison rate contain.

The high mortality rate of the termites is also caused by the wood rubber sample eaten by the termites that contains cellulose with its wood vinegar content which cannot be absorbed and digested by the termites' organ. According to Sari and Hadikusumo (2004), the termites mortality can be caused by two aspects; first, it is because the extract

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substance of the wood skin or the other wood parts which is used as preservative material cause some protozoa in their organ disappear, and/or second, the extract has caused the termites' nerve system damage. Dry-wood-termites destroy a part of unprotected woods by preservative material, except the other kinds of woods that has contained high natural preservative.

The percentage of reducing wood rubber test samples weight

The study result shows that the higher the concentration rate of wood vinegar, the fewer the rubber wood sample weight reduces. This reducing is caused if a wood is preserved with wood vinegar; it will be avoided from wood destroyers and poisonous for the dry-wood-termites. According to the fact above, fewer the rubbers wood weights which are consumed by dry-wood-termites.

The result is also suitable with analysis of variant, which the concentration treatment and wood vinegar can completely influence to the percentage of decreasing the sample weight of rubber wood test.

The percentage of lost wood rubber weight can be classified based on the wood's strength grade toward termites made by Sornnuwat (1995) in Febrianto *et al* (2000). The study showed that the crude wood vinegar made the rubber wood has a good endurance, whereas the wood vinegar treatment from distillation process and its residue resulted a better endurance.

The chemical compound of anti-termites compound that has more potential (its effectiveness) is assumed to be at the distillate wood vinegar. According to the study result, the chemical compounds composition of wood vinegar contains phenol and acid. High composition of acid and phenol is a potential to be developed as wood preservative material, that phenolic compound has high poison rate. The distillate wood vinegar that is used as rubber wood preservative treated to dry-wood-termites probably have high potential poison rate. It is proved because the termites was just able to eat 0.5 % of rubber wood (The endurance rate was very strong), whereas on the control sample (unpreserved rubber wood sample), the average percentage of reducing weight was 2.04%. It was because the unpreserved rubber wood would be easy to be destroyed by the termites.

Potential of galam's wood vinegar as Antifungi

The results show that wood vinegar concentrates absolutely influence the fungi growth inhibition. The kind of wood vinegar and concentrate and the combination of its kind do not significantly influence the fungi growth pressure. It does not mean galam's wood vinegar does not contain poisonous compound, but either the crude wood vinegar or distillate wood vinegar and even the residue with both high and low concentration definitely have bioactive nature which influences fungi growth population. It can be found that the growth inhibition rate varies from low level to high one.

The bioactive existence within the three kinds of wood vinegar in this research results in hampering *S. commune* growth. It is caused by the bioactive compounds that accumulate grease globule in the fungi cell's cytoplasm which destroys cell organelles mainly mitochondria and nucleus membrane cell of *S. commune*. The obstructive growth of the fungi in this study may be because of decreasing oxygen absorbing by the disturbed mitochondria that its membrane and crista are obstructed, that as a result of fact the energy (ATP) produced for its cell growth and proliferation goes down. Therefore, the *S. commune's* cell growth is normally destructed. 2 - furaldehyde compounds have utility as ointments and other chemicals , whereas for toxic poisons used in grasses and toxic fungi (fungicides) (Norhfurfural 2008).

The destructive fact that in taking the oxygen continually by a bioactive compound within the preservative extract can cause the damaged mitochondria and it will make mitochondria goes through metabolism dysfunction, one of organelles for protein synthesis. Then, cells fission and growth get

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obstacle and finally the cell is not able to reproduce to form the new cell (Purwantisari 2005).

Chemical Compound of Galam's Wood Vinegar

The analysis of chemistry compounds in galam's wood vinegar using GCMS shows that galam's wood vinegar consists of three chemical compounds; they are acid, carbonyl, and phenol (Figure 3-5 and Table 1).

Table 1.The mass spectrum of the three kinds of wood vinegar

No	Compounds	Retention time (minute) - Relative percentage (%)		
		crude wood vinegar	Distillated wood vinegar	residue of distillated wood vinegar
1	Pentanoic acid	2.63 - 0.57	2.63 - 1.00	2.62 - 2.85
2	2H-Pyran, 3,4-dihydro-	-	2.72 - 1.02	-
3	2-Furancarboxaldehyde	3.18 - 17.93	3.18 - 37.84	3.18 - 11.73
4	Ethanol, 2-butoxy-	-	-	4.12 - 2.54
5	2-Cyclopenten-1-one, 2-methyl-	4.15 - 1.91	4.15 - 2.71	-
6	Ethanone, 1-(2-furanyl)-	4.22 - 1.29	4.22 - 1.91	-
7	Butanoic acid, 4-hydroxy-	4.30 - 1.73	-	4.30 - 4.91
8	5-METHYLFURFURAL	4.97 - 2.27	4.97 - 6.69	4.97 - 1.51
9	Methyl 2-furoate	-	5.15 - 0.51	-
10	2-Cyclopenten-1-one, 3-methyl-	5.02 - 1.52	-	-
11	Phenol	5.23 - 9.14	5.23 - 3.75	5.22 - 4.85
12	CORYLONE $$ 2-HYDROXY-3-METHYL-	5.93 - 3.09	5.94 - 1.21	5.93 - 5.79
13	2-Norbornanone	6.11 - 1.07	-	6.11 - 1.30
14	2,3-Dimethyl-2-cyclopenten-1-on...	-	6.11 - 1.90	-
15	Phenol, 2-methyl-	6.32 - 1.97	6.33 - 2.35	6.32 - 1.30
16	Phenol, 4-methyl-	6.64 - 2.12	6.64 - 2.37	6.63 - 3.21
17	Methyl ethyl cyclopentene	-	6.69 - 0.82	-
18	Phenol, 2-methoxy-	6.86 - 8.53	6.87 - 13.83	6.86 - 8.16
19	Maltol	-	-	7.23 - 1.36
20	3-ETHYL-2-HYDROXY-2-CYCLOPENTEN	7.31 - 0.85	-	-
21	Phenol, 2,6-dimethoxy-	-	-	7.45 - 15.23
22	Phenol, 3,5-dimethyl-	7.71 - 1.17	7.72 - 1.60	-
23	2-Methoxy-4-methylphenol	-	8.19 - 0.61	-
24	2-Methoxy-4-methylphenol	8.39 - 5.75	8.39 - 8.94	8.39 - 3.24
25	1-Pentene, 3-ethyl-	8.61 - 1.24	-	8.61 - 2.19
26	Phenol, 2-methoxy-4-	9.62 - 8.38	9.62 - 3.43	9.61 - 1.38
27	3,4-Altrosan	10.25 - 1.57	-	-
28	Phenol, 2,6-dimethoxy-	-	-	10.36 - 4.67
29	Phenol, 2,6-dimethoxy-	10.58 - 12.14	10.59 - 4.07	10.58 - 18.67
30	2',4'-Dihydroxypropiophenone	-	10.81 - 0.90	-
31	Benzene, 1,2,3-trimethoxy-5-met...	11.25 - 0.77	-	11.24 - 1.36
32	2,4-Dimethyl-3-(methoxycarbonyl...	11.50 - 2.64	-	-
33	3-Hydroxy-4-methoxybenzoic acid	11.82 - 6.51	11.83 - 1.52	11.82 - 2.28
34	5-tert-Butylpyrogallol	12.81 - 3.65	12.81 - 1.02	-
35	2',4'-Dihydroxyacetophenone oxime	13.01 - 1.07	-	-
36	Benzene, 1,1'-[[(4-methylphenyl...	13.80 - 1.12	-	-
37	Benzaldehyde, 4-hydroxy-3,5-dim...	-	-	14.38 - 1.43

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Based on the gas chromatogram, acid found in the crude wood vinegar (Fiq 3) is Butanoic Acid, 4-hydroxy- with retention time (Rt, minutes) and relative percentage (%) 4.30 minutes and 1.73%. This kind of compound is also found in the distillation residue (Fiq 4) with retention time 4.30 minutes and relative percentage 4.91%, but there has no finding result in distillate wood vinegar. One of carbonyl type compounds is 2-furancarboxaldehyde found in the crude wood vinegar at the retention time 3.18 minutes with relative percentage 17.93%. On the wood vinegar through distillation and distillation residue, this kind of compound is also found within the retention time and relative percentage sequently in 3.18 minutes-37.84% and 3.18 minutes-11.73%. Phenol type is found too in the three kinds of vinegar, one of the types is phenol, 2.6-dimethoxy. It is found in retention time 10.58 and relative percentage 12.14% for the crude wood vinegar, retention time 10.58 minutes and relative percentage 18.67 for distillate vinegar, whereas the distillation residue does not contain this kind of compound. These different compound compositions show that distillation process is able to separate the existing compounds. (Fiq 5).

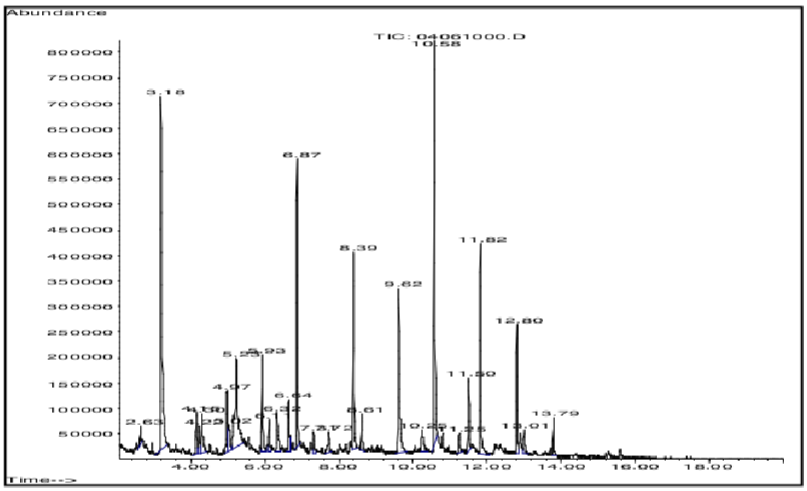

Figure 3. Chromatogram of crude wood vinegar

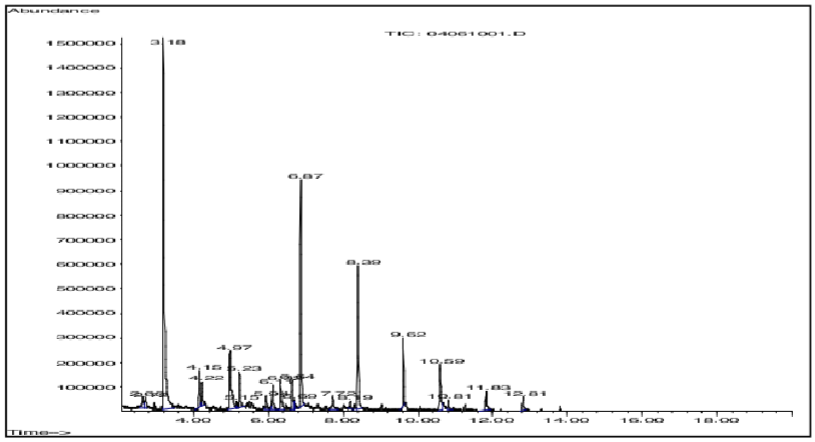

Figure 4.Chromatogram of distillated wood vinegar

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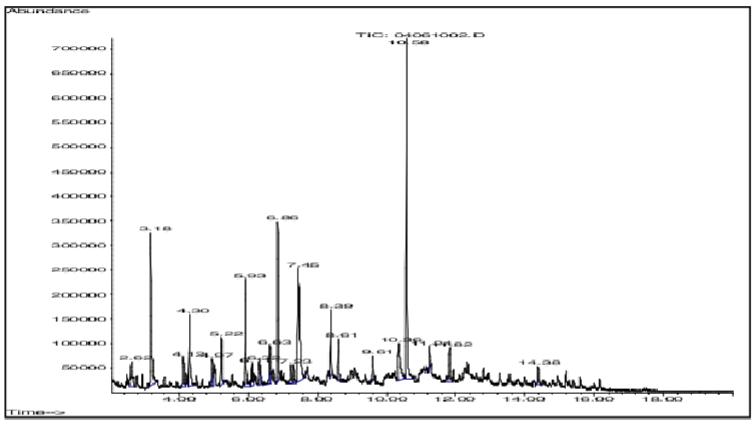

Figure 5.Chromatogram of residue of distillatedwood vinegar

According to Velmurugan, *et al* (2008), the compounds are also found in the wood vinegar of *Pinusdensiflora* and *Quercusserrata*. Furfural or 2-Furancarboxaldehyde can be used for preservative material (RIRDC 2006). This kind of compound is also usable for antifungi and anti-tumour (Guo *et al* 2008). There have been many research mention that phenol is a compound which actively runs as antimicrobial. Phenol is found in vary of plants and has been through an effectiveness test such as Gambier (Pambayun *et al* 2007), Galangale (Parwata and Dewi (2008), and many more. Fengel and Wegener (1984) reported that hemicelluloses thermal degradation provides acetic acid, methanol, furfural, aldehyde and ketones. The increasing in acidicity of wood vinegar was caused by the removal and leaching of organic acids from wood. Generally, acids are formed from the destructive reactions of cellulose, hemicelluloses and lignin.

CONCLUSIONS

1. Distillation process is usable to improve the quality of wood vinegar.
2. *Galam's* wood vinegar mixed with 50% aquadest is an effective and efficient anti-termites *C. cynocephalus* Light and antifungal *S. commune*.
3. *Galam's* wood vinegar contains three compounds; they are acid, carbonyl, and phenol.

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