

OPTIMIZATION OF INDUSTRIAL TRIAL: THE USE OF
CASSAVA FLOUR AS EXTENDER IN PLYWOOD
ADHESIVE MIX FOR PLYWOOD MANUFACTURE

By

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ABSTRACT

The aim of this work was to substitute cassava flour, a local material for imported wheat flour as extender in adhesive mix for plywood manufacture.

The previous laboratory trial of the adhesive mixture indicated that cassava could be used as a substitute for wheat flour. It became necessary to give it an industrial trial. Consequently five mills were selected for such a trial. The results showed that four out of the mills management were eager to use cassava flour as a substitute for the wheat flour.

INTRODUCTION

Plywood mills in Ghana use wheat flour as extender in the adhesive mix for plywood production. Wheat as a commodity cannot be grown in Ghana and is therefore imported. Its market price keeps soaring-up because it has competing uses. It is being used in Ghana as a food source particularly for bread and pastries making in addition to its use as extender in plywood mills.

Cassava, a locally grown commodity, like wheat, is a food source for most people in Ghana and is readily available in almost 8 regions of the country. Each plant of cassava produces 5-10 tubers which when freshly harvested have the following composition (Kochar, 1986):-

Starch	-	20 - 30%
Protein	-	2 – 3%
Water	-	75 – 80%
Fat	-	1%
Ash	-	1 – 1.5%

Normally, it is milled to produce starch for use in the confectionery and pharmaceutical industries in some countries. It is abundant in the country. The fact that its starch content is high means that it can be milled to produce flour to replace partially or completely wheat flour which is used in the adhesive mix used in the manufacture of plywood boards.

Forestry Research Institute of Ghana (FORIG) is a partner in the project entitled “Sustainable uptake of cassava as an industrial commodity” which is being funded by DFID of Britain. FORIG has been tasked to investigate the production of adhesive by using as ingredient cassava flour. Initial attempt to replace some of urea formaldehyde with phenol formaldehyde resins, the main ingredients in the adhesive mix for plywood production proved to be a very difficult task. However, attempt to replace partially or completely the use of wheat flour with cassava flour as extender showed very promising results. Consequently, efforts were directed in that direction.

Data collected from laboratory trials in which cassava flour was used as extender proved beyond doubt that it could be used. It therefore became necessary to attempt industrial trial for replacing wheat flour partially or completely in the plywood production mills.

Consequently, five mills were selected for such trials. The selected mills were:-

1. Logs and Lumber Limited - Kumasi
2. Naja David Plywood Mill (Bondplex) - Kumasi
3. Omega Wood Processing Limited - Kumasi
4. Western Veneer and Lumber Company - Takoradi
5. Ghana Prime Wood Company - Takoradi

VISIT TO PLYWOOD MILLS

1. Logs and Lumber Limited

This is a privately owned enterprise situated in Kumasi, the second largest city in Ghana. The factory produces lumber, veneer and plywood. Slicing and rotary veneers are produced in the mill. Its products are for the international and domestic markets. The project team met and discussed the issue of using cassava flour as extender with the management and memorandum of understanding was reached. The team was permitted to work in the factory from the 3rd February 2004.

Mode of Operation

Initially, the method employed by the company to prepare the adhesive mix for plywood production was used. This was then followed by the same technique except that cassava flour was used instead of wheat flour. The project team was allowed to perform the trials using the team's composition of the adhesive mix including resin, insecticide, hardener and water requirements provided by the company. The team provided the cassava flour which was used as the extender.

The team tried partial and complete replacement of the wheat flour. The composition of the adhesive-mix is given in Table 1. The board pressing parameters for hot and cold pressing is given in Tables 2 and 3.



Mill trials: Formulation of plywood adhesive with cassava flour. Water being poured into the mixing machine.

Table 1: Composition of the adhesive mix used to prepare 7-ply plywood board

Components	Parts by weight
Glue	64
Flour	20
Water	62
Hardener	06
insecticide	1

The mixing time was 12 minutes and the viscosity was measured with a flow cup. The viscosity measurement flow time was 60 seconds. The adhesive mix was used to prepare 7-ply plywood boards.

Table 2: The board parameters for the 7-ply plywood board

Characteristics	Board parameters (mm)
Number of plies	7
Face longitudinal	1.0
Cross-band (cross grain glued)	2.2
Long core (longitudinal grain)	2.0
Cross-band (cross grain glued)	2.2
Long core (longitudinal grain)	
Cross-band (cross grain glued)	2.2
Back (longitudinal grain)	1.0
Board thickness	12.6

Table 3: Board pressing conditions

Parameter	Cold pressing	Hot pressing
Pressure	3000 lb/m ²	2000 lb/m ²² 7½ minutes
Time	30 minutes	
Steam gauge pressure	-	1000 lb/m ²

Glue-bond quality of the hot panels were evaluated under dry conditions by the knife test method. The tests were carried out by the research team and the mill quality control expert. The results were satisfactory. The number of boards produced was 30 pieces instead of 80 to 90 pieces. Equal proportions of cassava and wheat flour were also used to prepared adhesive mix for plywood production. The number of boards obtained for that trial was 85 as expected.

Observations

The process quality control of processing parameters was generally poor due to lack of equipment and skilled manpower. Moisture content of boards and veneer were not measured. There was no means for measuring veneer thickness.

The roller spreaders were in poor conditions. The roller spreader was hand-fed with glue leading to losses. The roller rubber was worn out. The pressing machines were leaking profusely. There were no control press charts. There was no spread rate (g/m²) measurement equipment.

Comments

Reports from the trial indicated that cassava flour would give low production and high consumption of glue.

2. Naja David Plywood Company (Bondplex)

Bondplex is a privately owned mill situated in Kumasi. It produces only plywood and veneer for domestic and international markets. The project team met and discussed the issue of using cassava as extenders with the management. Initially the Production Manager was skeptical and was not interested. However, the General Manager managed to convince him to give the process a trial. The team, thereafter had full cooperation from the production management. Both liquid and powdered urea formaldehyde resins were used for the production of 5-ply and 3-ply plywood boards using cassava flour as extender in both cases.



Cassava flour extended glue spread on veneer sheets.

Tables 4 & 5 gives the adhesive-mix preparation for both liquid and powdered urea formaldehyde resins.

Table 4: Composition of adhesive mix for plywood manufacture (liquid resin)

Parameters	Parts by weight
Resin (liquid)	165
Flour (cassava)	36
Hardener, H-23	8
Insecticide	1
Water	20

Table 5: Composition of adhesive mix for plywood manufacture (powder resin)

Parameters	Parts by weight
Resin (powder)	100
Hardener, H-23	5
Cassava flour	32
Insecticide	1
H ₂ O	92

The viscosities measured for the prepared adhesive mix by using liquid and powdered resins were 76 and 75 seconds respectively. The board construction conditions were as follows:-

Pressing plate temperature	-	115°
Plywood width (5-ply)	-	12mm
Pressing time	-	5 – 6 minutes
Pressure	-	110 – 120 ka/m ²

The glue-bond quality of the hot panels were evaluated under dry conditions by the knife test method.

The liquid and powdered resin adhesive mix were used to produce 62 and 58 boards respectively. These were the expected numbers in their normal operations.

Comments

The production management was very happy with the results and expressed great interest to use cassava flour as extender for production of urea formaldehyde boards. Management wanted to know the cost of cassava flour per kilo, and the economics of using cassava flour.

3. Omega Wood Processing Limited

This mill is also in Kumasi. Its produces lumber, veneer and plywood for domestic and international markets. The project team discussed the issue of using cassava flour as extender with management and the team was given the permission to use the premises for the studies.

Mode of operation

The project team was allowed to perform the trial by using the team's composition of the adhesive mix including urea formaldehyde resin, insecticide, hardener and water requirements provided by the company. The team provided the cassava flour which was used as extender.



Glue-coated veneer sheets ready to go to the pressing machine.

The composition of the adhesive mix is given in Table 6.

Table 6: Composition of the adhesive mix used for preparing the 5-ply plywood board

Component	Parts by Weight
Resin (UF)	50
Water	46
Hardener	2.5
Cassava flour	16
Insecticide	.5

Prior to the addition of the hardener the mixture was blended for about an hour to avoid the presence of lumps. Powdered resin was used.

After the addition of the hardener the mixture was stirred for 10 minutes. The viscosity as measured by the flow-cup was 58 seconds.

The adhesive-mix was used to prepare 3-ply plywood boards. The number of board, produced was 56. Cold pressing time was 4 minutes. Knife-test was performed and the results was very good.

Comment: Production management was very happy of the outcome. The management wanted the cost of cassava per kilo and a guarantee source of good quality cassava flour.

4. Western Veneer and Lumber Company

This is a state-owned enterprise. It is situated in Takoradi. The factory produces lumber, veneer and plywood for domestic and international markets.

Operation at the Mill

Four different trials were performed with varying weights of cassava flour and wheat flour mixed together and cassava flour only as extender in the adhesive-mix used for the plywood production.



Glue-coated veneer sheets being packed into pressing machine.

Table 7 gives the composition of the adhesive mix of the first trial. The cassava used for this trial was provided by the project team.

Table 7: Composition of the adhesive mix used to prepare 3-ply plywood board

Component	Parts by weight
Liquid resin (UF)	45
Cassava flour	15
Wheat flour	10
Water	40
Hardener	1.5
insecticide	0.5

The mixing time was 4 minutes. The viscosity and measured by the flow-cup was 25 seconds. The conditions use for the construction of the 3-ply plywood were:

Pressing time	12 minutes
Pressing temperature	110° C
Pressing pressure	130 bar

The trial was repeated by using cassava flour provided by the company. The viscosity as recorded by the use of flow-cup was 10 seconds.

Another trial was made with 20 kg of cassava flour and 5 kg of wheat flour with corresponding amounts of UF, water, hardener and insecticide. The cassava flour was provided by the project team. The viscosity as measured with the flow-cup was 15 seconds. 3-ply plywood boards were constructed. The number of boards obtained was 105 pieces.

Another trial was made with only 25 kg of cassava flour with corresponding variation of water, resin (UF) hardener and insecticide. The viscosity as measured by the flow-cup was 11 seconds and the number of boards obtained was 120 pieces.

Comments

Management was excited and expressed great interest in the use of cassava flour as extender for production of UF-bond boards. This Company already has quotation from Amasa Group of Companies.

5 Ghana Prime Wood

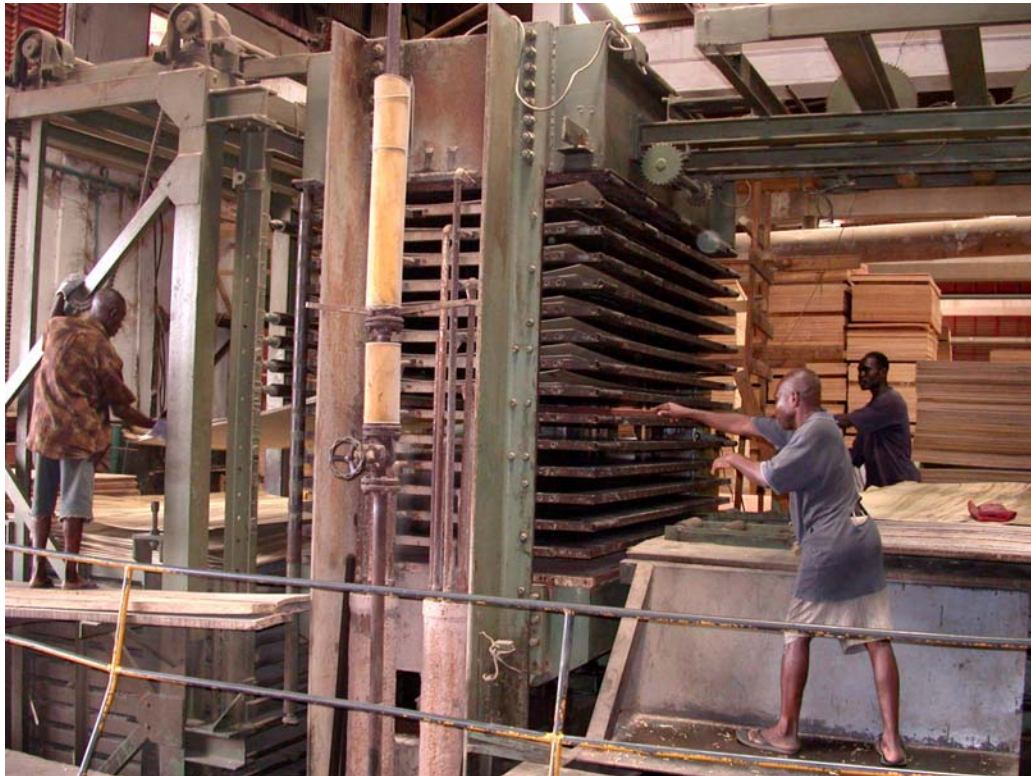
This is a privately owned timber company situated at Takoradi. The composition of the adhesive mix was as follows:-

Resin (UF)	-	25 kg
Cassava flour	-	25 kg
H ₂ O	-	55 kg
Hardener	-	0.5 kg

Insecticide - 0.5 kg

The viscosity as measured by the flow cup was 10 seconds. The condition, for construction of the 3-ply plywood boards were:-

Pressing time - 10 minutes
Pressing temperature - 250°F
Pressing pressure - 90 bar



Plywood being removed after hot pressing.

Comments

Management was happy of the outcome and expressed interest to use cassava flour as extender.

Training Workshop

Due to the various concerns expressed during the trials, a training workshop was organized so as to assess, re-assure and reconcile the differences that occurred during the mill trials. This was conducted on 25th February 2004, a report of which is attached to this document.

CONCLUSION

The plywood manufacturing trials were undertaken at five plywood mills in Kumasi and Takoradi between 3rd February 2004 and 18th February 2004. During the period under review about 500 pieces of plywood of different plies were produced. Glue-bond quality of the hot panels were evaluated under dry conditions by the knife test method. The results were satisfactory.

The cooperating mills enthusiastically expressed great interest in the use of cassava flour as extender for the production of UF-bond boards except Logs and Lumber Limited (LLL) in Kumasi.