Optimization of oil extraction from *Moringa Oleifera* and *Jatropha curcus* using Ram and Spindle presses

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ABSTRACT

In order to realize greater benefit from agroforstry practice, there is need to increase utilization of other products from the trees. Some of the ways of increasing utilization is to use the leaves, fruits, stems, flowers and roots of the trees. One way of utilizing the fruits is to extract oil from it. The main objective of the study was to determine the optimum oil output from *Moringa oreifera* and *Jatropha curcus* using Ram and Spindle presses. An existing Ram press with cage bars was tested using different ratios of 0%, 33.3%, 50%, 66.7% and 100% hurled seeds. Pipe perforated with 1.0mm, 1.5mm, 2.5mm and 3.2mm diameter holes were designed, manufactured such that they fitted in the Ram press. They were tested using the best ratio of hurled seeds that gave the highest output from the unmodified Ram press. The Spindle press was tested using different ratios of 0%, 50% and 100% hurled seeds. The best ratio for both *Moringa* and *Jatropha* was found to be 50% hurled seeds when using the Ram press. When using a Spindle press the maximum oil output was obtained from 100% hurled *Jatropha* and *Moringa* seeds. It is found that the best Ram press cage for *Moringa* and *Jatropha* is 1.5mm hole size made from perforated steel pipe.

Key words: Cage bars, Optimisation, Ram press, Spindle press, utilisation

INTRODUCTION

The promotion of agroforestry faces a very low rate of adoption in Malawi and possible in other countries as well. One way of increasing the adoption rate is to promote utilization of other products from the trees such as leaves, fruits, stem, flower and root of the trees. Alternative way of utilizing the fruits is to extract oil from its seeds. Oil content and proportion of various fatty acids in oil seeds vary with growing conditions. High temperatures in seed development reduce oil content and proportion of linoic acid (Hyman, 1994).

Moringa seed kernels contain about 40% oil by weight. The oil can be used for soap making and consumption. Besides the industrial uses such as fine lubricant and perfumery, the fatty acids profile of the oil with its very high content of oleic acid may make it an oil with potential for further industrial application (Machell, 1994). After pressing, the cake can be dried, stored and be used for water purification or as a fertilizer (Horticulture Development Organisation of Malawi, 2000). *Jatropha curcus* oil is mostly used as lamp oil. It is also used for soap making (Hyman, 1994).

Oil can be extracted by hand or machines. In traditional methods of processing of oil seeds, the extraction efficiency is about 40% (Intermediate Technology Publications, 1993). Use of hand is tedious and has a very low output. However not all machines are suitable for use with tree seeds. Ram and Spindle presses are some of the mechanical methods of extracting oil from seeds.

A Ram press was developed in Tanzania in 1986 by Appropriate Technology International (ATI). It is also known as Bielenberg Ram press named after the developer. It is a simple, low cost manual technology for oil extraction. It was initially developed for extracting oil from sunflower specifically the soft type (Hyman, 1993). It gives 10-15% oil on weight per weight basis at a rate of 7-10kg/h of sunflower depending on the strength of the operator (Horticulture Development Organisation of Malawi, 2000). With other type of seeds other than

sunflower, modifications in the press may maximize the extraction rate. For instance, the ideal spacing of the bars are reported to be narrower for sesame and copra than sunflower seeds (Hyman, 1993). For best output, each user has to adjust the press to suit him or her. Too low a pressure yields little oil while too much pressure increases the strenuousness of the work and may cause the adjustment screw to jam, resulting in damaging the press (Hyman, 1994). The cage spaces (gaps) can range from 0.5mm to 1.5mm depending on the accuracy of the manufacture, however they are supposed to be uniform (Figure 1).

It is recommended that the residues that already have been pressed is run through the press again. This loose material will force out the densely packed seed residue in the cage that might otherwise harden overnight and become difficult to remove the next day (Tanzania Small Industries Development Organization, 1990). In the case of *Moringa*, the residues harden after few minutes, making it the most difficult seeds to process.

A spindle press is a manual technology for oil extraction that resembles a tobacco bailer. The perforations of the cage for spindle press should have mean diameter of 1.0mm. It has a higher capacity compare to the Ram press, processing about 15kg/hour.

The objective of this study was to determine the optimum oil output from M*oringa oreifera*, and *Jaropha curcus* seeds using Ram and Spindle presses.

Figure 1:

MATERIAL AND METHODS

1. About 1kg of *Moringa* was used for each trial run. The ratio of the hurled to unhulled seeds were varied at 0%, 33%, 59%, 66.7% and 100%. The total amounts of seeds were roasted on an electric hot plate. It was then pressed in unmodified Ram press. The crude oil obtained after pressing was sieved using a

kitchen sieve. The mass of the oil was then measured using an electronic balance. The percentage crude oil extracted was then determined on weight-by-weight basis. The results were then compared statistically using analysis of variance (ANOVA) in order to determine the best ratio for optimum oil extraction.

2. Four different cages were designed having the same dimensions as the original cage so that they could be fixed in the same frame of the existing Ram press. The cages were made from galvanised steel pipes. The holes were made using drill bits of 1.00mm, 1.50mm, 2.50mm and 3.20mm diameters respectively. Reinforcements were made from steel plates cut using electric-arc and then welded to the cage cylinder (Figure 2). Each cage was tested for oil extraction using the best ratio of hurled to unhurled seeds from step 1 and replicated three times. The results were compared with unmodified cage and statistically analysed using ANOVA to determine the best cage.
3. The ratios of 0%, 50% and 100% for *Jatropha* and *Moringa* seeds were pressed in a Spindle press. The net weight of 5kg seed was used for each trial and replicated three times.

Figure 2:

RESULTS AND DISCUSSION

PERFORMANCE OF RAM PRESS

Figure 3

The least oil yield from *Moringa* was obtained from 100% hurled seeds giving an oil yield of 5.4% , while the highest yield was for 1:1 ratio of hurled to unhurled seed yielding 6.1% (Figure 3). The ratios of 33.3%, 66.7% and 100% hurled *Moringa* yielded 5.5%, 5.7% and 5.6% oil content respectively, however these were not significantly different from the fully hurled *Moringa* at 5% level of significance. The 1:1 ratio is therefore the best and was significantly high compared to all the other ratios.

Figure 4:

It can be noted that all the modified cages yielded higher oil output than the unmodified cage (Figure 4). The 1.00mm cage gave the highest oil yield of 13%, however this was not significantly different from the 1.50mm cage which yielded 11.3%. It is much easier to drill 1.50mm than 1.00mm holes since drill bits break more often

when using the small size. Due to drill breakages during manufacture, it may be cheaper to manufacture 1.5mm holes unless specialized tools such as dividing head are available to assist in drilling. 7.8% and 7.1% were the respective oil outputs for the 2.50mm and 3.20mm cages. These were significantly different from 1.50mm cage but not from each other.

Figure 5

When all the Jatropha was hurled (100%), the oil yield was the least at 14.3% while the maximum was at 1:1 ratio of hurled to unhurled seed giving 23%. The second was 33% hurled (which was not significantly different from the 1:1 ratio), followed by fully unhurled (0%) and 67% hurled seeds, which yielded 21.8%, 20.5% and 18.2% in that order (Figure 5). The later two are not statistically different at 5% level of significance (Appendix Table 1.32). The 50% hurled seed can therefore be said to yield the maximum oil.

Figure 6

Figure 6 shows the performance of different types of cages at 1:1 ratio of hurled to unhurled *Jatropha*. The unmodified cage yielded the highest (23%) which was not significantly different from a 1.50mm cage with output of 20.6%. The oil extraction from 1.00mm, 2.5mm and 3.20mm cages were 15.4%, 18.7% and 14.7% respectively. There was no significant difference between 1.00mm and 3.20mm cages, similarly 1.5mm and 2.5mm cages, though the later was significantly different from unmodified cage at 5% level of confidence (Appendix 1.40). The unmodified cage can therefore be said to be appropriate for *Jatropha,* however due to its complexity in fabrication the 1.5mm cage can be the best option. In addition, it is much easier to remove the residues from the perforated pipe cage than the bar cages.

PERFORMANCE OF SPINDLE PRESS

Figure 7

The Spindle press gave the highest output of Moringa oil when all the seed were hurled (100%). This was followed by the 50% shelled to hurled seed ratio. The least output was given when the no seeds were hurled (Figure 7).

Figure 8

100% hurled *Jatropha* seeds gave the highest oil output of 20.5% (Figure 8). The least (14.7%), was obtained for 0% hurled seeds. The 50% shelled seed ratio yielded the average oil output (17.2%). The fully hurled *Jatropha* seed is therefore appropriate when using the Spindle press.

CONCLUSION

1. The best ratio of the hurled to unhurled seed for both *Moringa* and *Jatropha* is 1:1 when using Ram press. When using a Spindle press the maximum oil yield is obtained when *Jatropha* and *Moringa* seeds are 100% hurled.

2. The best cage for Moringa and Jatropha is the 1.50mm cage made from a perforated steel pipe.

ACKNOWLEDGEMENTS

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REFERENCE

Horticulture Development Organisation of Malawi, 2000 *Horticulture in Malawi Magazine Vol. 2/No. 3/2000*. Malawi-German Project Promotion of Horticulture, Lilongwe 3, Malawi

Hyman E. L., 1994 *Oil Seed Production and Processing in Malawi*. Appropriate Technology International.

Washing, D.C. 20036.

Intermediate Technology Publications and United Nations Development Fund for Women, 1993 *Food Cycle Technology Source Books – OIL PROCESSING*. Intermediate Technology Publications Limited, 103-105 Southamption Row, London WC1B 4HH, United Kingdom

Machell K., 1994 *Report on the Extraction of Moringa oil from Moringa oil seeds*. Intermediate Technolgy Zimbabwe, Harare, Zimbabwe.

Tanzanian Small Industry Development Organisation(SIDO), 1990 *Information about the Bielenberg Ram Press Designed by CAMARTEC*. Tanzania Lith Ltd., Arusha.

FIGURES

Figure 1: Cage bar for unmodified Ram press

Figure 2: Modified perforated galvanized cage for Ram press

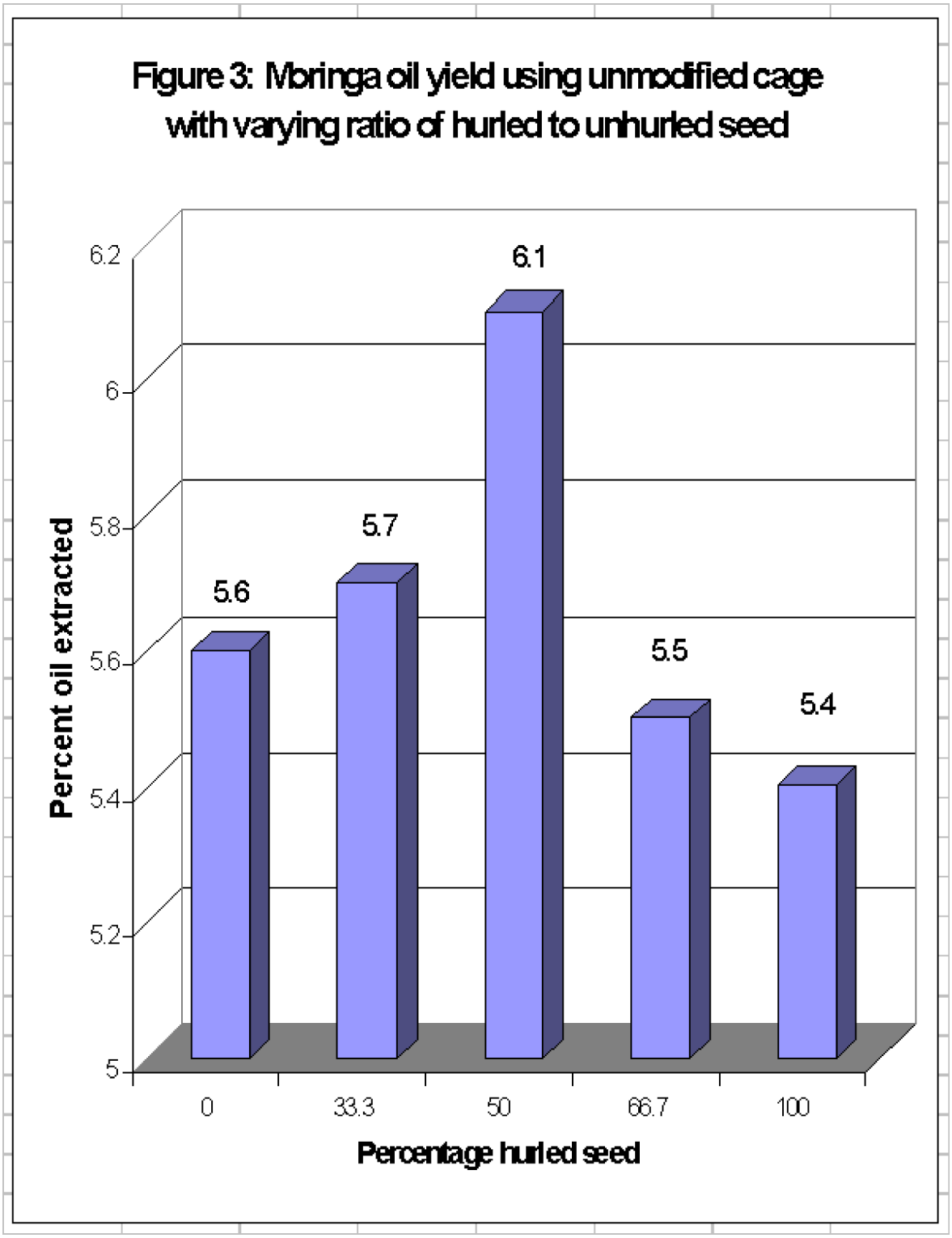


Figure 3: Moringa oil yield using unmodified cage with varying ratio of hurled to unhurled seed
Percent oil extracted
6.2
6
5.8
5.6
5.4
5.2
5
5.6
5.7
6.1
5.5
5.4
0
33.3
50
66.7
100
Percentage hurled seed

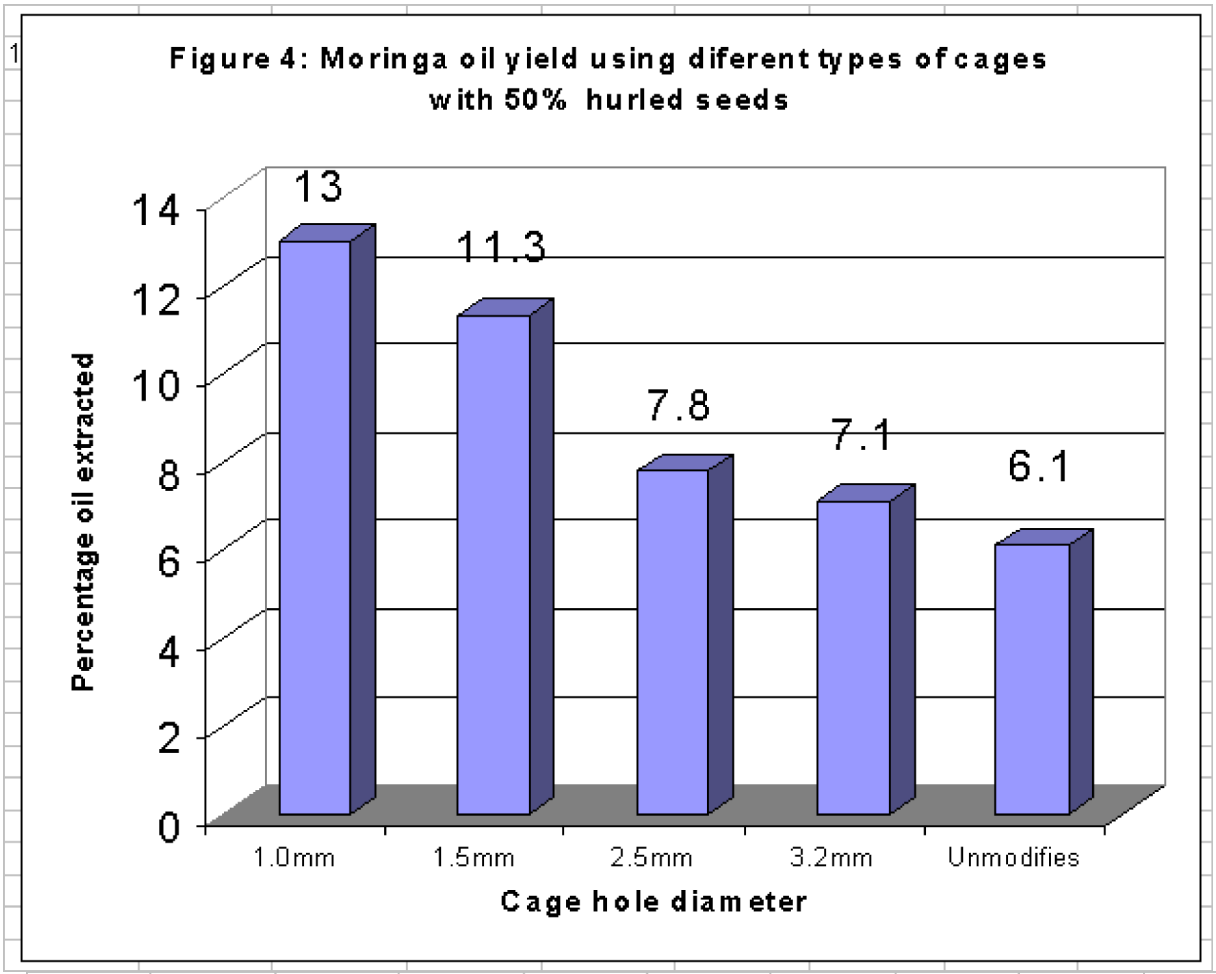


Figure 4: Moringa oil yield using diferent types of cages with 50% hurled seeds
Percentage oil extracted
0
2
4
6
8
10
12
14
13
11.3
7.8
7.1
6.1
1.0mm
1.5mm
2.5mm
3.2mm
Unmodifies
Cage hole diameter

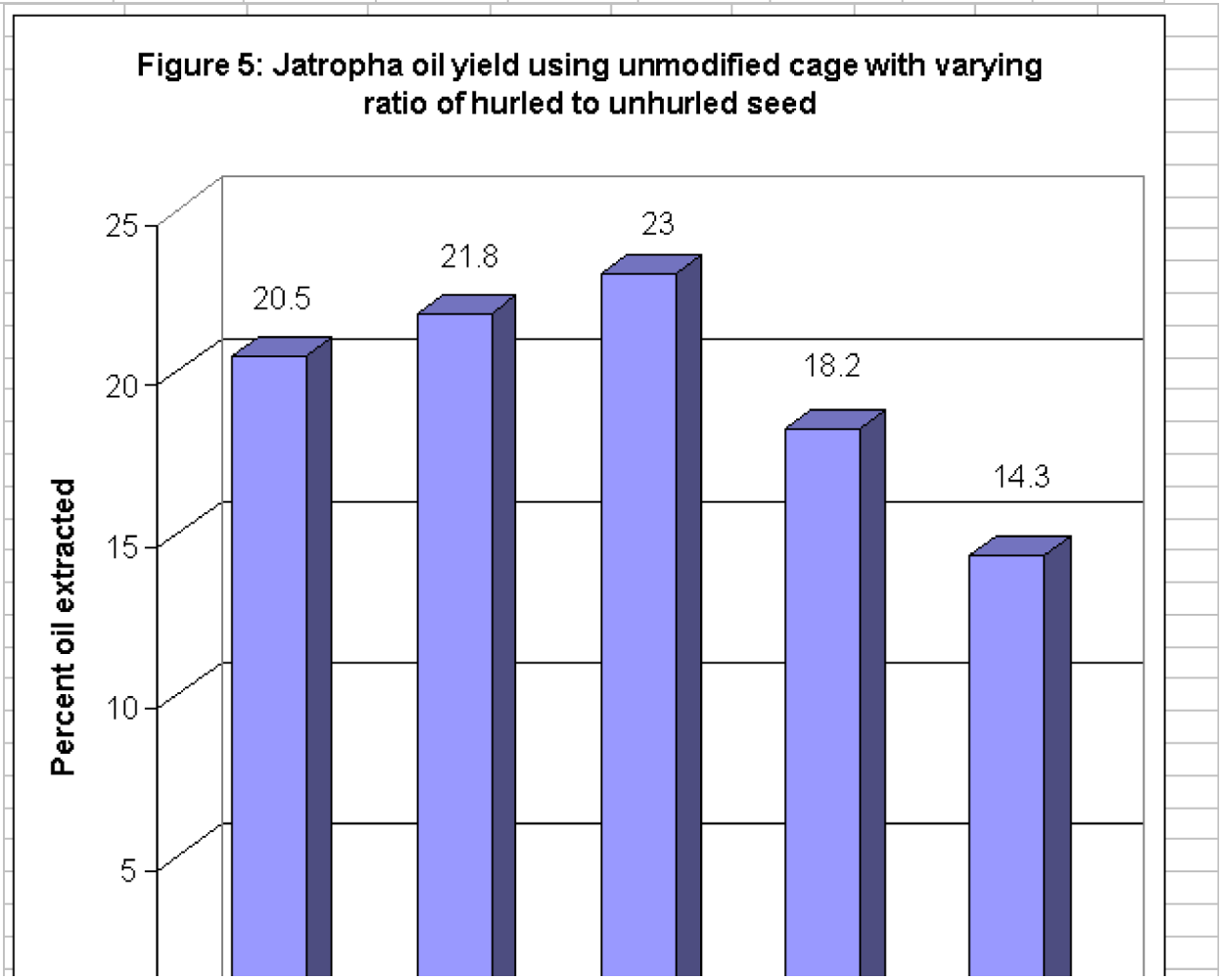
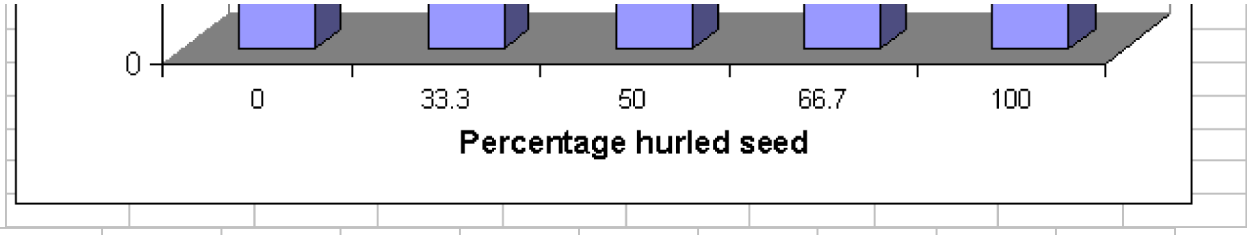


Figure 5: Jatropha oil yield using unmodified cage with varying ratio of hurled to unhurled seed
Percent oil extracted
5
10
15
20
25
20.5
21.8
23
18.2
14.3


0
0
33.3
50
66.7
100
Percentage hurled seed

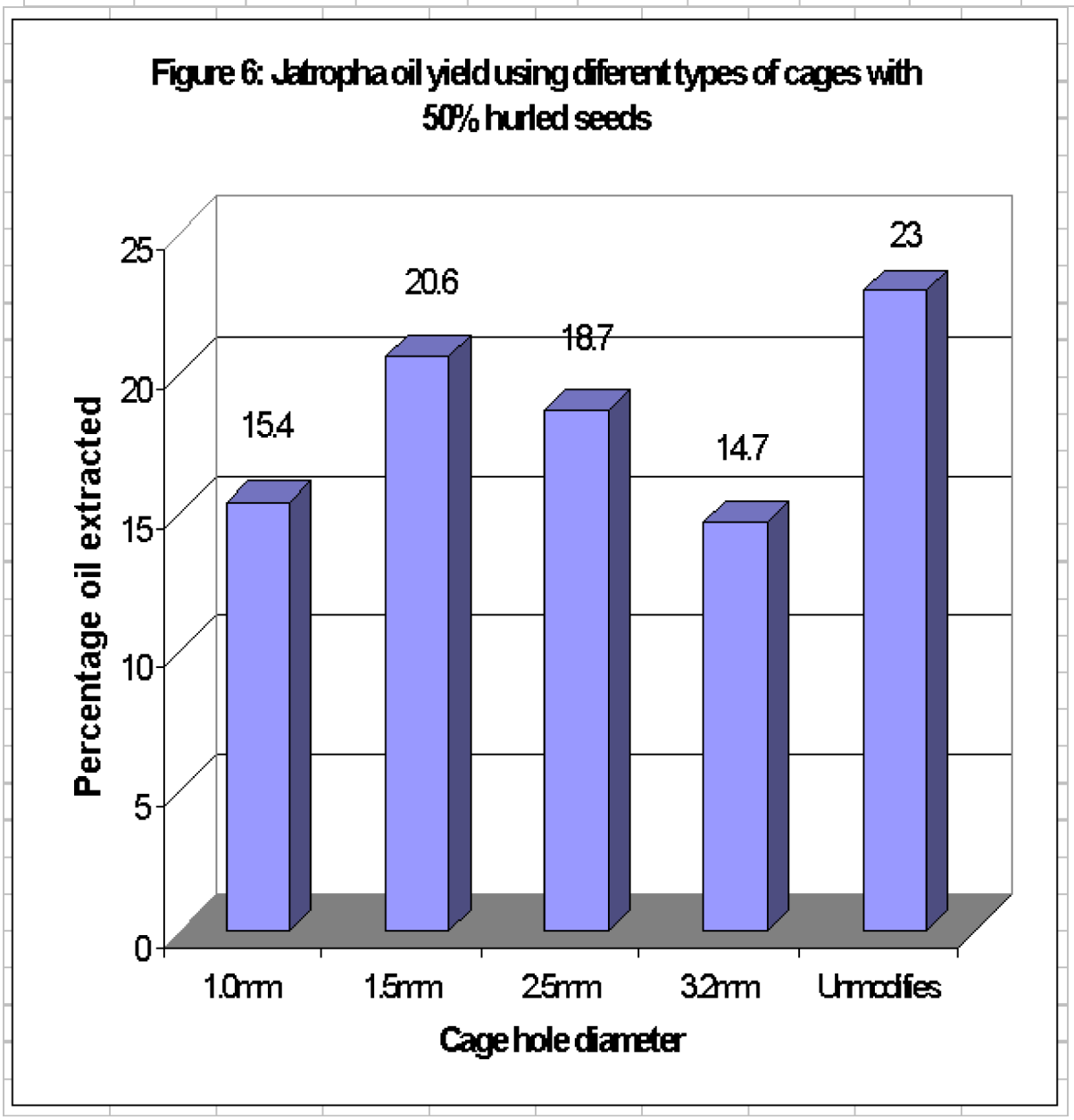


Figure 6: Jatropha oil yield using diferent types of cages with 50% hurled seeds
Percentage oil extracted
0
5
10
15
20
25
15.4
20.6
18.7
14.7
23
1.0mm
1.5mm
2.5mm
3.2mm
Unmodifies
Cage hole diameter

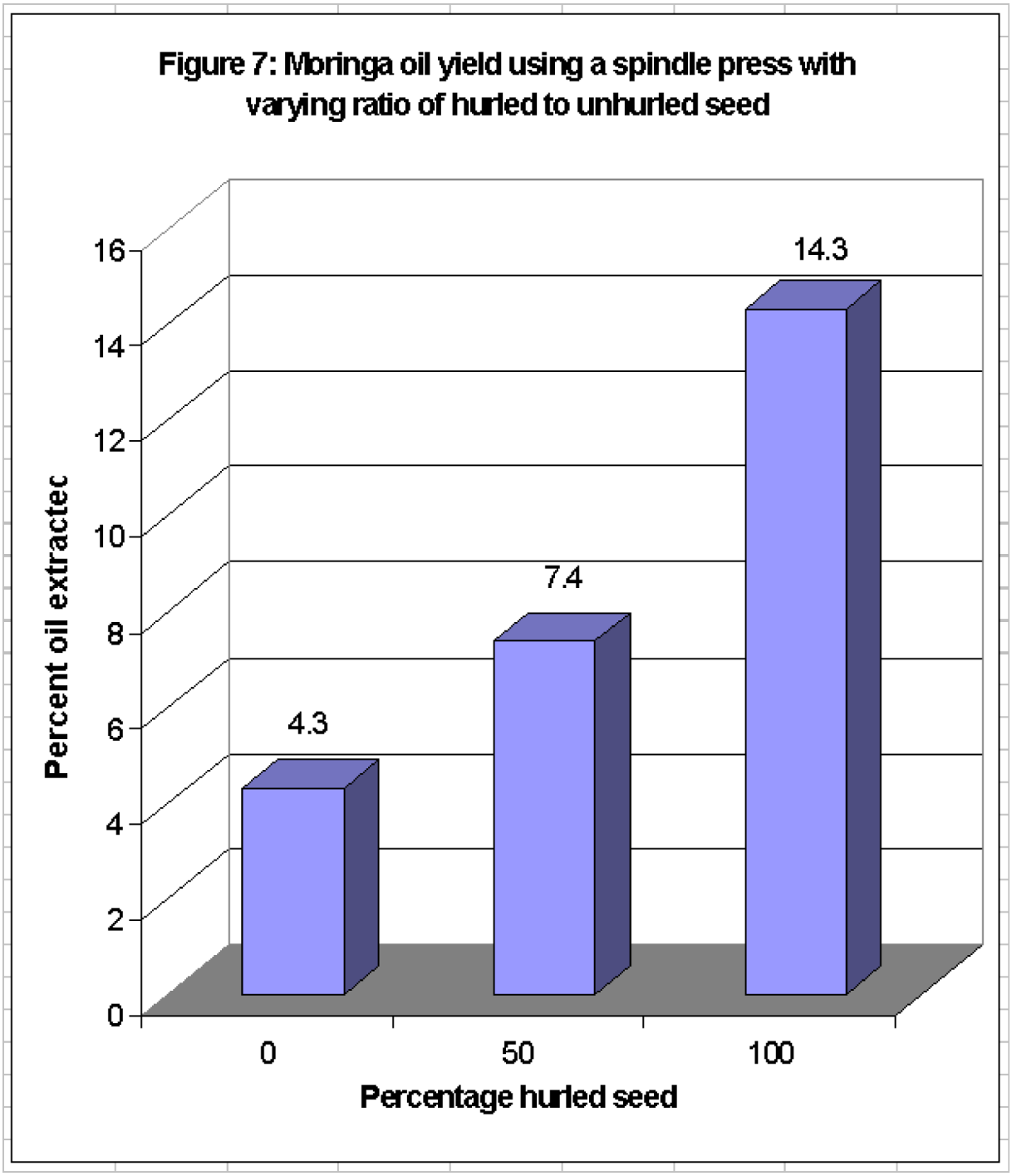
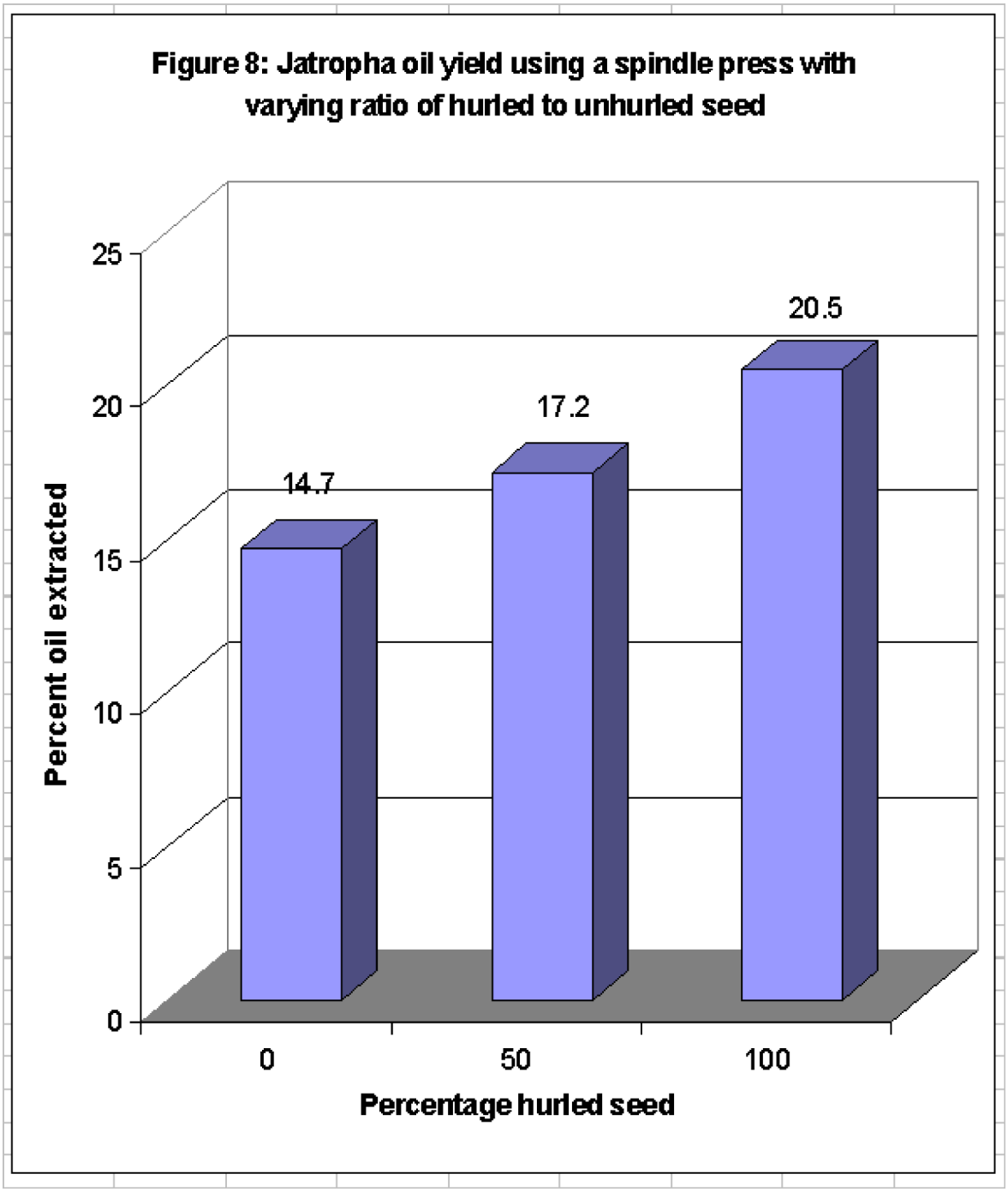


Figure 7: Moringa oil yield using a spindle press with varying ratio of hurled to unhurled seed
Percent oil extractec
16
14
12
10
8
6
4
2
0
4.3
7.4
14.3
0
50
100
Percentage hurled seed



APPENDICES

1.10 Data analysis for Moringa oil at different ratios using unmodified cage.

Table 1.11 ANOVA

Source of Variation	Degrees of freedom	Sum of squares	Mean Squares	F- Ratio
Ratios	4	74.2666	18.5667	0.5938

Error	10	312.6667	31.2667
Total	14	386.9333	

$F_{4,10,0.01} = 5.99$

Coefficient of Variance (CV%) = $(\sqrt{31.2667})/851 * 15 * 100\% = 9.9\%$

Therefore the results of this experiment are reliable.

Table 1.12 Crude Moringa oil Mean Yields at Different Ratios using unmodified Ram press

Ratio	Mean oil Yield (g/kg)
0:1	54 a
1:2	55 a
1:1	61 b
2:1	57 a
1:0	56 a

SED = $\sqrt{(2*31.2667/5)} = 3.54$

1.20 Analysis of Data on Moringa oil using different cages

TABLE 1.21 ANOVA

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F-Ratio
Cages	4	10309.956	2577.489	23.59**
Error	10	1092.52	109.252	

Total	14	11402.476

$f_{4,10,0.01} = 5.99$

Coefficient of Variance (CV%) = $(\sqrt{109.252})/1356.6 * 15 * 100\% = 11.56\%$

Therefore the results of this experiment are reliable.

Table 1.22 Crude Moringa oil Mean Yields for Different Cages at a Ratio of 1:1

Cage	Mean oil Yield (g/kg)	Significant differences at 5% level of significance
1.00mm	129.7	a
1.50mm	112.5	a
2.50mm	78.4	b
3.20mm	71.0	b, c
unmodified	60.7	c

SED = $\sqrt{(2*109.252/5)} = 6.61$

1.30 Statistical determination of differences in Jatropha oil output at different ratios using unmodified Ram press

Table 1.31 ANOVA

Source of Variation	Degrees of freedom	Sum of squares	Mean squares	F-Ratio
Ratios	4	14236.17	3559.04	16.46**
Error	10	2161.77	216.18	
Total	14	16397.94		

$f_{4,10,0.01} = 5.99$

Coefficient of Variance (CV%) = (√216.18)/16397.94 *15 *100% = 1.34%

Therefore the results of this experiment are realiable

Table 1.32 Crude Jatropha oil Mean Yields at Different Ratios of unshelled to shelled seeds using unmodified Ram press

Ratio	Mean oil Yield (g/kg)	Significant difference at 5% level of significance (t-statistic)
0:1	205.1	a
1:2	218.1	a, b
1:1	230.0	b
2:1	181.6	c
1:0	143.0	d

SED = √(2*216.18/5) = 9.3

1.40 Analysising data on cages for Jatropha sung a ratio of 1:1

Table 1.41 ANOVA

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F-Ratio
Cages	4	14695.51	3673.878	40.79**
Error	10	900.63	90.063	
Total	14	15596.14		

$f_{4,10,0.01} = 5.99$

Coefficient of Variance (CV%) = (√37.492)/4545.3 *15 *100% = 2.02%

Therefore the results of this experiment are reliable

Table 1.42 Crude Jatropha oil Mean Yields of Different Cages at a ratio of 1:1

Cage	Mean oil Yield (g/kg)	Significant differences at 5% level of significance (t-statistic)
1:00mm	153.8	a
1:50mm	206.2	b, c
2:50mm	187.3	b
3:20mm	147.0	a
unmodified	230.0	c

SED = $\sqrt{(2*90.063/5)} = 6.00$