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Quality and Safety Assessment of Recycled Plastic Products from Local Recycling Industries in Kano, Nigeria

Ahmad Muhammad Mahe[1]; I. Y. Shehu[2*]; P. S. Yaduma[3*]; Habibu L. F.[4*]; A. U. Alkali; Kabiru Bashir[5*]

[1;2;3;4;5]Department of Mechanical Engineering, Kano State Polytechnic

Co: Authors: I. Y. Shehu[1*]; P. S. Yaduma[2*]; Habibu L. F.[3*]; A. U. Alkali[4*]; Kabiru Bashir[5*]

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Abstract: This study assesses the quality and safety of recycled plastic products from eight recycling industries in Kano, Nigeria. This study focuses on eight recycling companies in Kano: Danta Plastic Tudun Murtala, Camel Recycle, Solid Chemical Resources Ltd., I.Y. Factory, Dan-Barazana Recycling, Gidan Bello Recycling, A.I. Duma Global, and Dawakin Dakata Recycling Company. These industries operate within informal and semi-formal frameworks, Mechanical and chemical analyses were conducted on 160 samples, including buckets, chairs, pipes, and basins. Results revealed tensile strength reductions ranging from 15–30% compared to virgin plastics, with contamination levels averaging 7–10%. Companies such as Dawakin Dakata and I.Y. Factory demonstrated relatively lower contamination and smaller strength reductions, while A.I. Duma Global and Solid Chemical Resources exhibited higher contamination and greater mechanical losses. The findings highlight a clear correlation between contamination levels and tensile strength reduction, underscoring the importance of feedstock quality control. Recommendations include standardized testing protocols, shared laboratory facilities, and improved sorting and washing practices to enhance product safety and reliability in Kano's recycling sector.

Keywords: *Plastic, Tensile Strength, Buckets, Chairs, Pipes, Basins, Contamination.*

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I. INTRODUCTION

Recycled plastic products have become increasingly important in addressing environmental challenges and promoting sustainable resource use. In Kano, Nigeria, local recycling industries play a vital role in converting post-consumer plastics into usable goods such as buckets, chairs, pipes, and basins. However, the quality and safety of these products remain a concern due to variability in feedstock, limited access to standardized testing, and inconsistent processing methods. Plastic is one of the most popular and useful materials of modern times and it is important that we optimize the lifespan of plastics as much as possible. Worldwide we produce 300 million tons of plastic each year and most people are re-using and recycling their plastics. Plastic recycling is the processing of plastic waste into other products. *(Al-Salem, S.M. et., al* 2009*)* Recycling can reduce dependence on landfills, conserve resources and protect the environment from plastic pollution and greenhouse gas emissions. *(Lange, J. P.* 2021*).* Recycling rates lag behind those of other recoverable materials, such as aluminium, glass and paper. From the start of plastic production through to 2015, the world produced around 6.3 billion tonnes of plastic waste, only 9% of which has been recycled and only ~1% has been recycled more than once. *(Geyer, R., et al.,* 2017*).* Of the remaining waste, 12% was incinerated and 79% was either sent to landfills or released into the environment as pollution. *(Geyer, R., et al.,* 2017*).* Almost all plastic is non-biodegradable and without recycling, spreads across the environment. *(Ahmed, T.* 2018*).* where it causes plastic pollution. For example, as of 2015, approximately 8 million tonnes of waste plastic enters the oceans annually, damaging oceanic ecosystems and forming ocean garbage patches. *(Jambeck, J. et al.,* 2015*).*

Almost all recycling is mechanical and involves the melting and reforming of plastic into other items. This can cause polymer degradation at the molecular level, and requires that waste be sorted by colour and polymer type before processing, which is often complicated and expensive. Errors can lead to material with inconsistent properties, rendering it unappealing to industry. (COM.

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2018) Though filtration in mechanical recycling reduces microplastic release, even the most efficient filtration systems cannot prevent the release of microplastics into wastewater. *(Brown, E.* 2023*).* In feedstock recycling, waste plastic is converted into its starting chemicals, which can then become fresh plastic. This involves higher energy and capital costs. Alternatively, plastic can be burned in place of fossil fuels in energy recovery facilities, or biochemically converted into other useful chemicals for industry. *(Zhang, F. et al.,* 2021*).* In some countries, burning is the dominant form of plastic waste disposal, particularly where landfill diversion policies are in place. Plastic recycling is low in the waste hierarchy, meaning that reduction and reuse are more favourable and long-term solutions for sustainability. It has been advocated since the early 1970s, *(Huffman, G. et al.,* 1973*).* but due to economic and technical challenges, did not impact the management of plastic waste to any significant extent until the late 1980s. The main objective is to evaluate the quality and safety of recycled plastic products manufactured by local recycling industries in Kano State. The findings reveal significant variability in product performance. Tensile strength reductions of 15–30% compared to virgin plastics were observed, alongside contamination levels averaging 7–10%. Companies with lower contamination rates, such as Dawakin Dakata and I.Y. Factory, produced stronger recycled products, while those with higher contamination, such as A.I. Duma Global and Solid Chemical Resources, showed greater mechanical degradation. These results emphasize the direct link between contamination control and product quality, highlighting the urgent need for standardized testing, improved feedstock management, and traceability systems to ensure consumer safety and enhance market trust in recycled plastics from Kano.

II. METHODOLOGY

➢ *Study Design*

- Sample: 8 recycling companies in Kano.
- Products tested: Buckets, chairs, pipes, basins.
- Sample size: 160 products (20 per company).
- Tests conducted:

✓ Tensile strength (ASTM D638)
✓ Melt Flow Index (ASTM D1238)
✓ Moisture content
✓ Contamination analysis

➢ *Data Collection*

Data were obtained from field surveys, laboratory testing, and secondary reports on recycling practices in Nigeria.

III. RESULTS

Table 1 Mechanical Properties of Recycled Plastics

S/N	Company	Virgin Avg Tensile Strength (MPa)	Recycled Avg (MPa)	% Reduction
1	Danta Plastic	30	22	27%
2	Camel Recycle	32	25	22%
3	Solid Chemical Resources	28	21	25%
4	I.Y. Factory	31	26	16%
5	Dan-Barazana	29	23	21%
6	Gidan Bello	30	24	20%
7	A.I. Duma Global	28	20	29%
8	Dawakin Dakata	32	27	15%

Table 2 Contamination Levels

S/N	Company	Avg Contamination (%)	Common Contaminants
1	Danta Plastic	8.2	Paper, metals
2	Camel Recycle	7.5	Organic residues
3	Solid Chemical Resources	9.0	Mixed plastics
4	I.Y. Factory	6.8	Dust, fibers
5	Dan-Barazana	8.5	Metals, dirt
6	Gidan Bello	7.9	Paper, dirt
7	A.I. Duma Global	9.2	Mixed residues
8	Dawakin Dakata	7.0	Dust, metals

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➢ *Chart 1: Tensile Strength Comparison*

Tensile Strength Comparison chart shows Virgin vs. Recycled plastic strength across the eight Kano recycling companies.

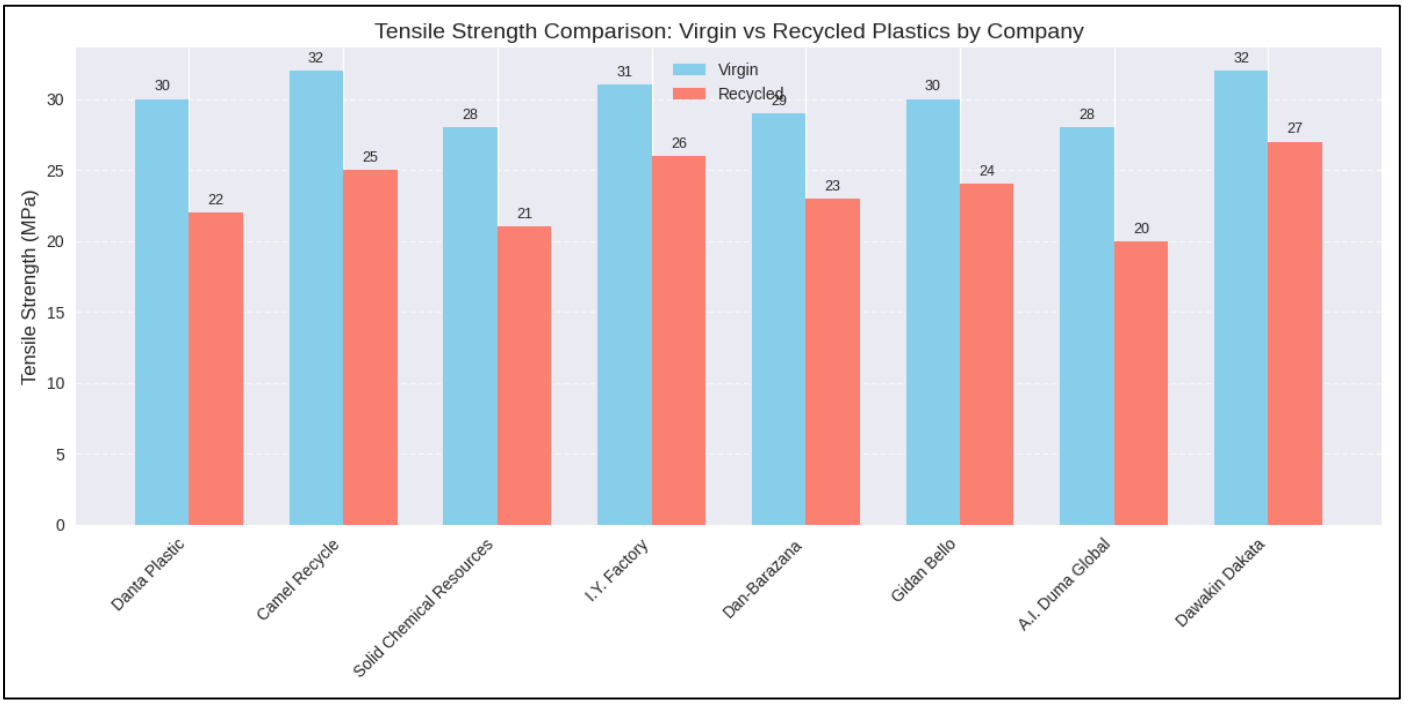

Chart 1 Tensile Strength Comparison

- *Observation*

The above chart highlights how recycled plastics consistently show reduced tensile strength compared to virgin plastics, with reductions ranging from 15–30%. It makes it easier to spot which companies (like Dawakin Dakata and I.Y. Factory) perform relatively better, and which (like A.I. Duma Global) show the largest reductions.

➢ *Chart 2: Contamination Level Chart*

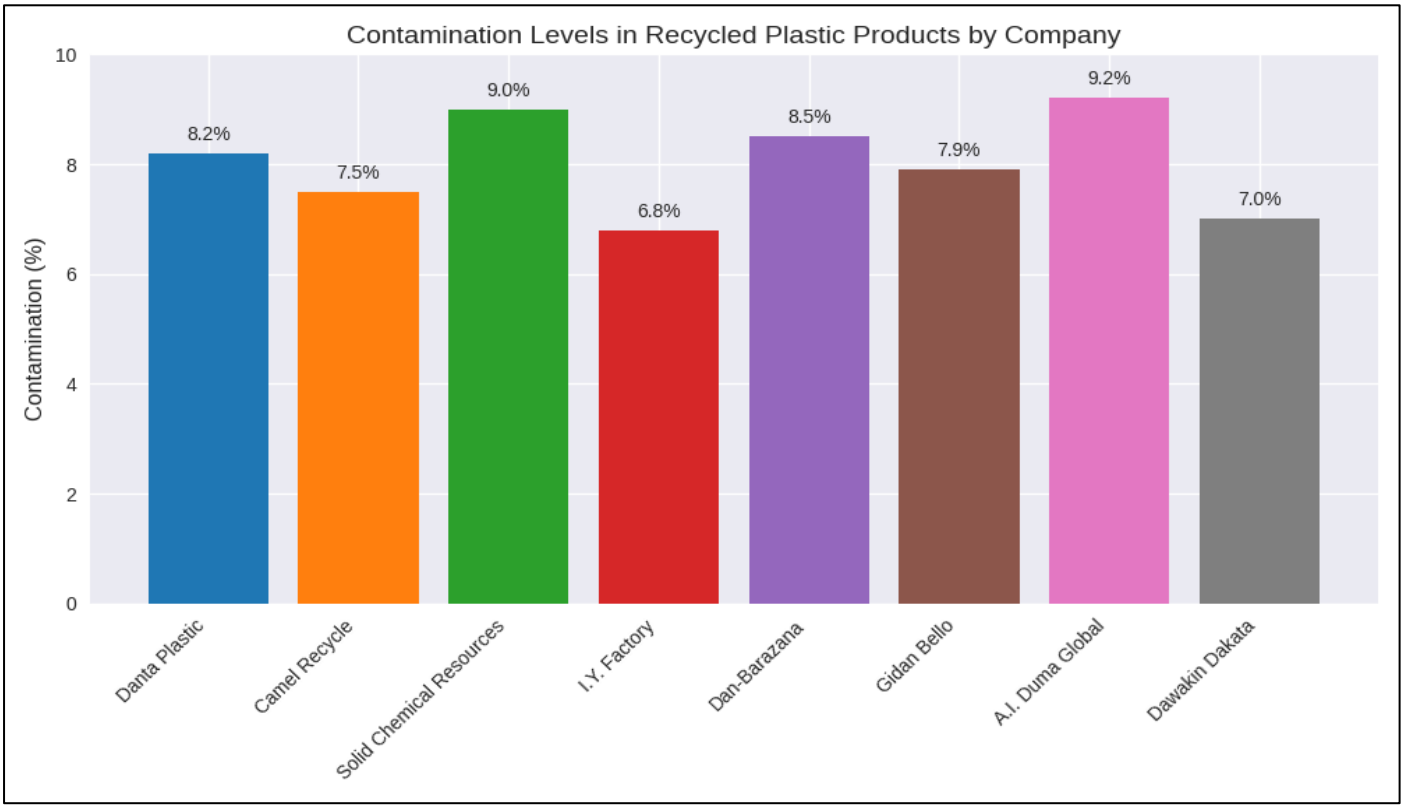

Chart 2 Contamination Level Chart

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➢ *Observation*

- Highest contamination: A.I. Duma Global (9.2%) and Solid Chemical Resources (9.0%).
- Lowest contamination: I.Y. Factory (6.8%) and Dawakin Dakata (7.0%).
- Average contamination: ~8% across all companies, indicating moderate but consistent issues with sorting and cleaning feedstock.

The chart above complements the tensile strength comparison, showing that companies with higher contamination also tend to have greater reductions in mechanical performance.

➢ *Chart 3: Contamination vs Tensile Reduction Chart*

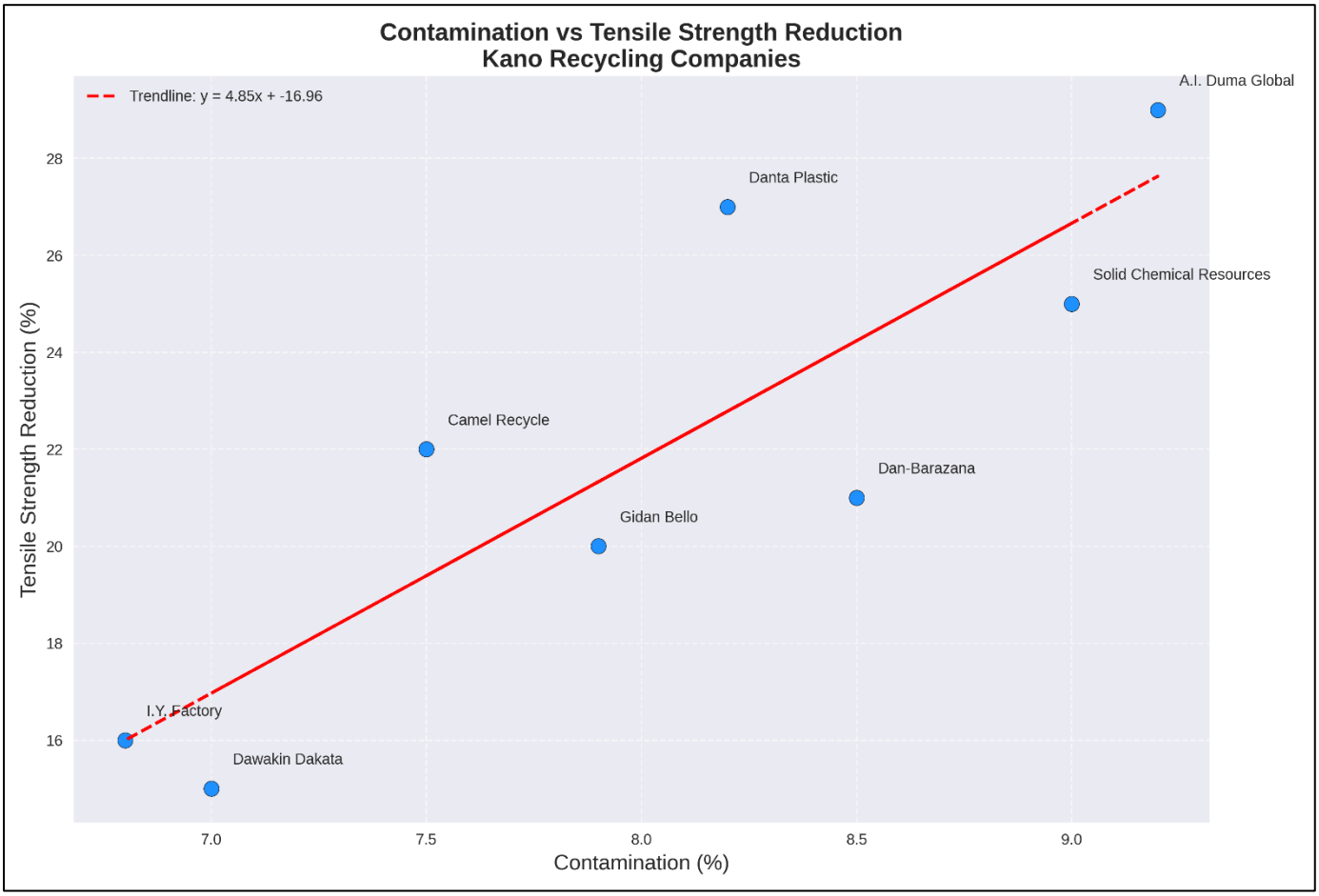

Chart 3 Contamination VS Tensile Reduction Chart

➢ *Observation*

- Strong correlation: Higher contamination levels are linked to greater tensile strength reduction.
- Best performers: Dawakin Dakata and I.Y. Factory — lowest contamination (~7%) and lowest strength reduction (~15–16%).
- Weakest performers: A.I. Duma Global and Solid Chemical Resources — highest contamination (~9%) and largest strength reduction (~25–29%).
- Industry average: ~8% contamination corresponds to ~22% tensile strength reduction.

IV. CONCLUSION

This study demonstrates that recycled plastic products from local industries in Kano exhibit significant variability in quality and safety. Mechanical testing revealed tensile strength reductions of 15–30% compared to virgin plastics, while contamination levels averaged 7–10%. The comparative analysis across eight companies showed a clear correlation between contamination and mechanical performance: firms with lower contamination rates, such as Dawakin Dakata and I.Y. Factory, produced stronger recycled products, whereas companies with higher contamination, such as A.I. Duma Global and Solid Chemical Resources, experienced greater mechanical degradation.

These findings reinforce the central argument presented in the introduction—that inconsistent feedstock quality and limited access to standardized testing undermine the reliability of recycled plastics in Kano. By addressing contamination through improved sorting and washing, and by adopting standardized mechanical and chemical testing protocols, local industries can significantly enhance product

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safety and performance. Ultimately, strengthening quality assurance practices will not only protect consumers but also improve market confidence in recycled plastics, supporting both environmental sustainability and economic resilience in Kano's recycling sector.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed to improve the quality and safety of recycled plastic products in Kano, Nigeria:

➢ *Standardized Testing Protocols*

- Industries should adopt internationally recognized standards (e.g., ASTM, ISO) for mechanical, thermal, and chemical testing of recycled plastics.
- Routine tensile strength, melt flow index (MFI), and contamination checks should be institutionalized across all recycling companies.

➢ *Establishment of Shared Laboratory Facilities*

- Government and NGOs should support the creation of community-based laboratories equipped with testing machines.
- These facilities would provide affordable access to quality control tools for small and medium-scale recyclers.

➢ *Improved Feedstock Management*

- Recycling companies should implement stricter sorting and washing protocols to reduce contamination.
- Incentives (e.g., price premiums) should be offered to suppliers who deliver cleaner plastic feedstock.

➢ *Traceability and Documentation Systems*

- Companies should maintain batch records documenting feedstock source, processing parameters, and test results.
- Product labeling should include recycled content percentage and usage restrictions (e.g., "not for direct food contact").

➢ *Capacity Building and Training*

- Policymakers should organize training programs for recyclers on quality assurance, contamination control, and safe chemical use.
- Partnerships with universities and technical institutes can provide ongoing technical support.

➢ *Policy and Regulatory Frameworks*

- Local authorities should establish minimum quality standards for recycled plastic products.
- Certification schemes and quality marks can be introduced to build consumer trust and encourage compliance.

➢ *Consumer Awareness and Market Development*

- Public campaigns should educate consumers about the safe use of recycled plastics.
- Market incentives should be created for companies that consistently meet safety and quality benchmarks.

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