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Research Article

Reduction of Systemic Microplastic and Nano Plastic Burden Using a Food-Grade Plastic Adsorptive Compound (PAC): A Proof-of-Concept Human Study

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ABSTRACT

Background: Microplastics and nanoplastics have emerged as pervasive environmental contaminants now detectable in human tissues, with potential links to oxidative stress, endocrine disruption and chronic inflammation. No established interventions currently exist to reduce internal plastic burden. The Plastic Adsorptive Compound (PAC) was developed as a food-grade oral supplement designed to adsorb ingested micro and nanoplastics within the gastrointestinal tract and facilitate their elimination before systemic absorption.

Methods: An open-label, proof-of-concept study pilot study (IRB-approved) enrolled seven adult participants who took PAC capsules two capsules three times daily with meals for 30 days. Each capsule contained food-grade ingredients designated as Generally Recognized as Safe (GRAS). Blood and saliva microplastic levels were assayed pre- and post-intervention using a standardized spectroscopic polymer identification assay.

Results: All participants completed the 30-day protocol without adverse events. Analysis demonstrated a mean 74% reduction in detectable plastic particle concentration in post-treatment blood samples compared with baseline values. Participants reported no significant gastrointestinal symptoms or other side effects, indicating good tolerability of PAC.

Conclusion: This preliminary study suggests that PAC may substantially reduce systemic micro- and nanoplastic burden through enteric adsorption and prevention of plastic absorption. These promising results warrant confirmation in larger, randomized, placebo-controlled trials to validate efficacy, define optimal dosing, and elucidate long-term safety and mechanisms of action.

Keywords: Microplastics; Nanoplastics; Adsorption; Detoxification; Nutraceutical intervention; Human health

INTRODUCTION

Microplastics (MPs) are commonly defined as plastic particles with a maximum dimension of <5 mm, whereas nanoplastics (NPs) are considered to be <1 µm in diameter—though terminology and operational definitions vary, with some authors using the 1 nm-1000 nm range to reflect colloidal behavior [1,2]. These particles originate either as primary sources (e.g., industrial microbeads, deliberately manufactured granules) or from secondary fragmentation of larger plastic items, often acquiring sorbed chemical additives, persistent organic pollutants, heavy metals, and microbial biofilms that can modify their physicochemical and toxicological properties [1,2].

Human exposure to MPs and NPs is now established *via* multiple routes: Ingestion (*via* foodstuffs, bottled water, and drinking water), inhalation (indoor and outdoor aerosolized particles and to a lesser extent dermal contact [3,4]. For instance, the World Health Organization (WHO) has reviewed data showing that conventional drinking-water treatments (coagulation, filtration, activated carbon) remove many larger particles but leave significant uncertainties regarding removal of nanoplastics and the potential health impacts of associated chemicals [3,5,20].

Human biomonitoring studies report that MPs/NPs can reach systemic compartments: MPs and NPs have been detected in human blood, lung tissue, liver tissue, kidney tissue, heart tissue, brain tissue, testes, semen, stool, and placental tissues—indicating

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translocation across physiological barriers [6-11]. For example, polyethylene terephthalate, polyethylene and polystyrene particles have been quantified in human blood using sensitive mass-spectrometry methods; microplastics have been visualized in term human placentas and in resected lung tissue [6,8].

Mechanistically, experimental and epidemiologic evidence implicate oxidative stress, inflammatory responses, immune dysregulation, endocrine disruption from plastic-associated chemicals, and microbiome perturbations as plausible pathways for adverse effects [12-15]. Although human causal evidence remains limited, a 2024 prospective study reported that the presence of micro-/nanoplastics within carotid atheroma plaques was significantly associated with increased risk of myocardial infarction, stroke or death over 34 months, strengthening concerns about cardiovascular effects [16].

Major public-health organizations call for standardized measurement methods, exposure metrics and clinical end-points, especially in relation to nano plastics [17,19]. In response to the absence of any recognized pharmacologic or nutraceutical intervention capable of reducing systemic micro- and nano plastic burden [18], Pure BioHealth developed a Plastic Adsorptive Compound (PAC), a food-grade formulation designed to sequester ingested plastic particles within the gastrointestinal tract and facilitate their safe elimination before systemic absorption.

MATERIALS AND METHODS

Study design

This prospective, single-arm, dose-controlled, open-label proof-of-concept study evaluated the effect of a food-grade Plastic Adsorptive Compound (PAC) on systemic micro and nano plastic (MP/NP) burden. The protocol received institutional review board (IRB) approval.

Participants

Eligible participants were adults aged 21 years or older, English-speaking, able to provide written informed consent, and willing to submit blood and saliva samples. Key exclusion criteria were pregnancy or nursing; chronic constipation; known allergy to any study-product component; inability to separate concomitant medications by at least one hour before or after dosing; or any condition judged by the investigator to compromise safety or compliance.

Intervention

PAC was supplied as vegan gel capsules containing food-grade, GRAS-designated ingredients. Participants self-administered two capsules three times daily with meals (breakfast, lunch, and dinner) with 5–8 ounces of water for 30 consecutive days (total daily dose: six capsules). Concomitant medications and supplements were permitted if taken at least one hour before or after PAC. Agents with substantial binding, adsorptive, chelating, or laxative properties (e.g., psyllium, cellulose, spirulina, certain laxatives) were discouraged to avoid confounding.

Specimen collection

Each participant received specimen kits: capillary blood collection using a dried blood spot card and saliva kits. Baseline blood and saliva were collected prior to the first PAC dose following kit instructions and returned to the laboratory. After 30 days of dosing, participants repeated blood and saliva collection with the remaining kits. Three participants did a two-week interim saliva analysis. Participants recorded dosing adherence and any adverse events in a paper diary and could contact the study team by phone or email as needed.

Laboratory analyses

Total MP/NP concentrations were quantified in blood and saliva by a pre specified third-party laboratory according to its standard operating procedures for polymer detection. All samples from a given participant were processed in batched runs to minimize inter-assay variability. The primary analytic variable was total detectable plastic particle concentration per matrix.

Outcomes

Co-primary outcomes were the percent change from baseline to post-treatment in total detectable plastic concentration in (1) blood and (2) saliva. Secondary outcomes were safety and tolerability based on self-reported Treatment-Emergent Adverse Events (TEAEs).

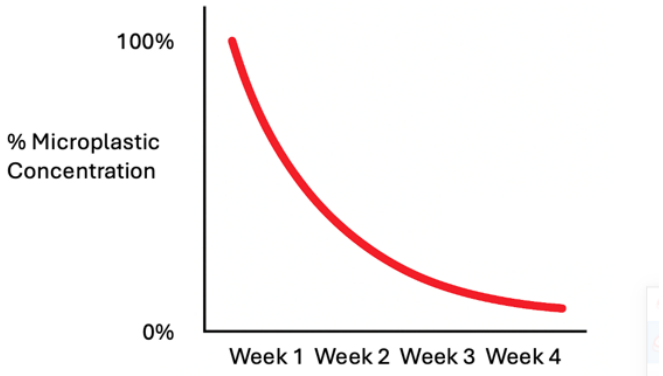

Figure 1: Plastic Concentration in Blood *vs.* Time

Sample size rationale

This exploratory investigation enrolled an initial cohort of seven participants to estimate within-subject changes, variance components, feasibility and safety and to inform power calculations for a subsequent randomized, controlled trial. The sample size was not based on formal power for hypothesis testing but on detecting large, biologically meaningful effects while minimizing participant exposure at the proof-of-concept stage.

Statistical analysis

Analyses followed a paired, within-subject framework. For each matrix (blood, saliva), percent change from baseline was calculated as (post-baseline) / baseline × 100. Summary statistics (mean, median, standard deviation and 95% confidence intervals) were reported. Depending on distributional characteristics, paired t-tests or nonparametric alternatives (e.g., Wilcoxon signed-rank test) were pre specified for exploratory inference. Missing post-treatment values were not imputed; participants with both baseline and post values contributed to efficacy analyses. Sensitivity analyses included robust nonparametric summaries to assess the impact of outliers.

RESULTS AND DISCUSSION

Seven participants (N=7) completed the 30-day study. Blood and saliva samples were provided at baseline and post-treatment for micro- and nano plastic quantification. Three participants submitted interim saliva tests after two weeks of taking PAC. Both particle counts and particle surface area were analyzed, as surface area ($4\pi r2$) represents the biologically active 'skin' of each particle and correlates strongly with toxicologic potential.

Across all participants, total plastic particle counts in blood

declined following PAC administration. When results were normalized by particle surface area, the magnitude of reduction was even greater, reflecting preferential depletion of larger or more reactive particles. Post-treatment reductions averaged 74% based on total particle counts and an average reduction of 94% when expressed as total particle surface area [17-20].

Parallel analysis of saliva samples demonstrated a similar overall decline in MP/NP burden after 30 days. Interestingly, in a subset of participants who submitted interim 2-week saliva samples, the particle counts transiently increased by approximately 500%, followed by a reduction two weeks later of roughly 300% relative to baseline by study completion. This biphasic response suggests that PAC may initially mobilize plastics from tissue reservoirs into circulation or excretory pathways before facilitating their elimination through gastrointestinal adsorption.

These findings support a dual mechanism of action for PAC:

- Adsorption at the gastrointestinal level, preventing further absorption of ingested plastics and
- Mobilization and subsequent adsorption of plastic particles released from tissues and organs, promoting systemic clearance.

No adverse events or tolerability issues were reported, and all participants completed the full dosing period without withdrawal. Collectively, these data indicate that short-term PAC supplementation was well-tolerated and produced substantial reductions in both circulating and salivary MP/NP burdens, potentially through complementary mechanisms of action.

CONCLUSION

The results of this proof-of-concept study demonstrate that short-term administration of the Plastic Adsorptive Compound (PAC) was safe, well-tolerated, and effective in reducing measurable micro- and nano plastic (MP/NP) burden in human biological matrices. All participants exhibited a favorable response, with consistent decreases in both blood and saliva particle counts and surface-area–weighted indices. These findings suggest that PAC functions through dual mechanisms of action-(1) gastrointestinal adsorption to prevent absorption of ingested plastics and (2) systemic mobilization and subsequent adsorption of pre-existing tissue-bound plastics.

Strengths of this investigation include:

- A 100% participant response rate, indicating uniform biological activity.
- Use of multiple validation methods for quantitative assessment.
- Analytical testing conducted using a Mayo Clinic–validated methodology, ensuring reproducibility and scientific rigor.
- Absence of any adverse events or tolerability issues throughout the study period.
- Emergence of consistent, biologically plausible response patterns across participants and matrices.

Limitations include the small sample size (n=7) inherent to this exploratory pilot design, the absence of a placebo control arm, and that nano plastic concentrations were calculated from polymer distributions rather than directly quantified.

Despite these limitations, the data provide compelling preliminary evidence supporting PAC as a novel, food-grade intervention capable of mitigating human MP/NP exposure. Larger, controlled clinical trials are warranted to confirm these results, optimize dosing strategies, and elucidate long-term safety and efficacy.

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