

WHAT DOES THE DISHWASHER WANT? UNRAVELING THE CO-EVOLUTION OF TECHNOLOGY AND BEHAVIOR

Nergis Ulubilir Coskun

Where you live determines how you clean. A preference for powder, liquid or tablet dishwashing detergent format differs globally. Understanding consumer behavior helps product manufacturers overcome consumer contradictions to find opportunity through the communication of the format's performance and eco-friendliness.



Dishwashing is a universal household chore that reflects the evolving habits, traditions, and values of modern-day households. In turn, regional, cultural and generational differences in values and behaviors inform the automatic dishwashing (ADW) landscape; influencing preferences in the duration and energy-ef-

ficiency of wash cycles, as well as the formulation and format of complementary detergents. But innovative dishwashing solutions are not only reflections of values and behavior; they can also be drivers of change. Industry innovation that both reflects the complex demands of the modern kitchen and shapes dishwash-

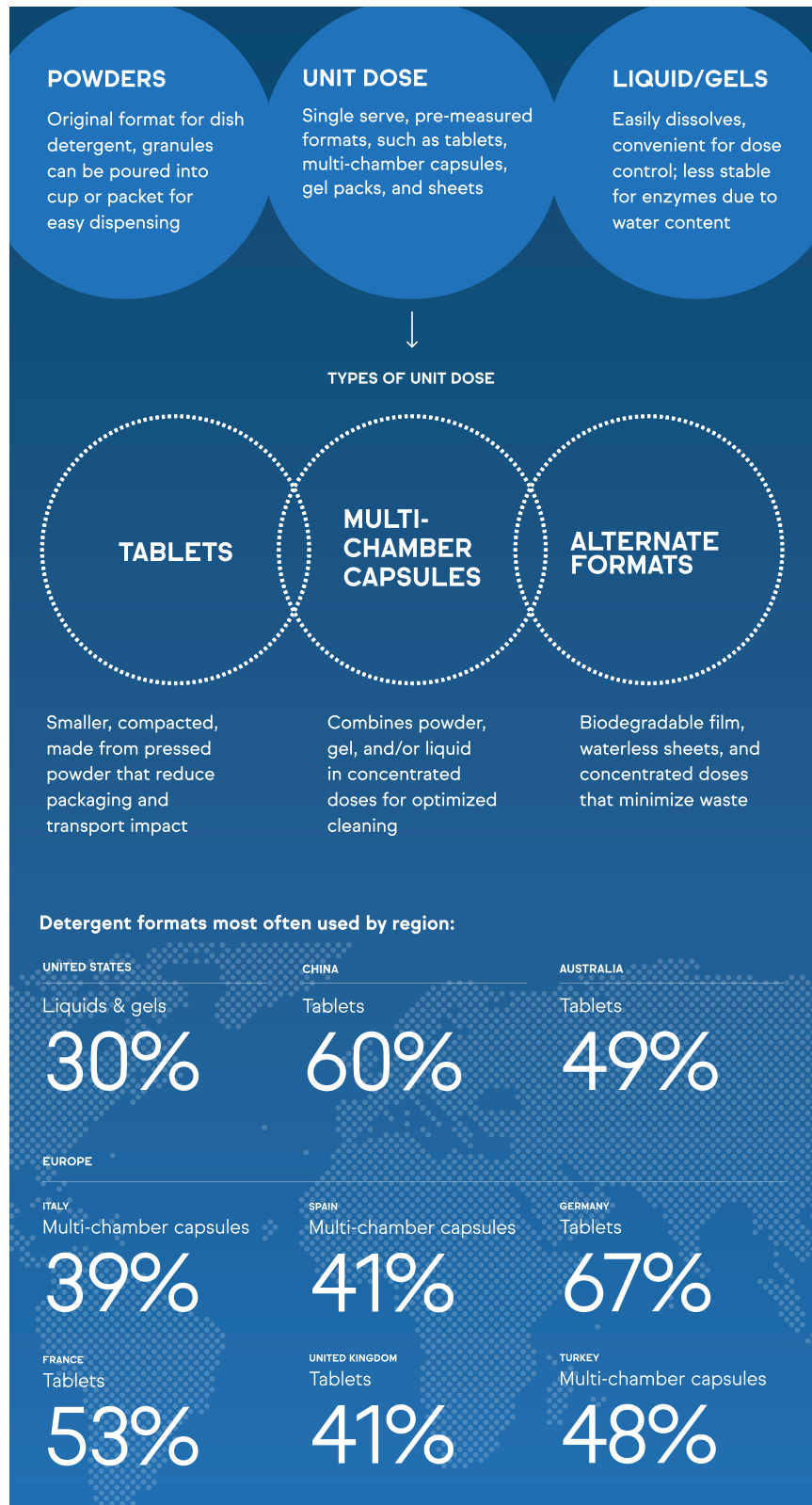
ing behavior requires industry leaders who bridge the gap between consumer data and advanced biotechnology.

CONSUMER BEHAVIOR SHAPES THE MARKET

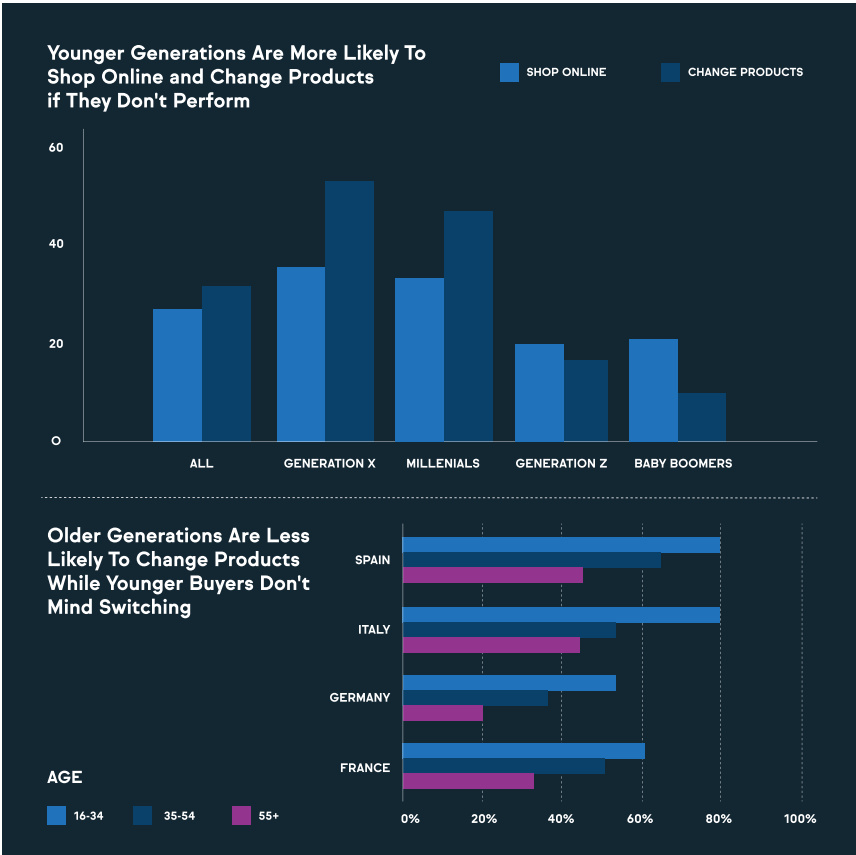
Variation in consumer habits and preferences means there is no single “best” solution for an effective dishwashing detergent, preventing dishwasher and detergent designers from focusing their efforts on a single standardized formulation or format. Over time, the dishwashing industry has evolved solutions that reflect a growing variety of consumer needs and habits. Modern appliances have adapted to support shorter run cycles, lower water consumption, and dirtier dish loads. Energy-efficient machines now come equipped with multiple cycles and modes that cater to the changing demands of consumers.

In recent years, emerging smart devices have begun to re-shape detergent product demands. For instance, auto-dosing machines require highly specific detergent formats geared toward automated dispensing. Meanwhile, some manufacturers are pushing the boundaries of the category entirely, experimenting with detergent-free high-speed dishwashers and AI-driven, nearly waterless technology.

As appliance manufacturers continue to innovate, detergent formulators must ensure their chemistries and chosen for-



Regional detergent format preferences. *Source: DISH issue 4*



Dish detergent preferences differ generationally. *Source: DISH issue 4*

mat synergize with new hardware and address consumer preferences. These demands have driven a shift from powder-based formats to more convenient and dose-controlled formats, such as unit doses and liquids/gels. While all regions have moved away from powders, preference for dose-controlled detergent formats varies regionally.

Technological innovations offer developers solutions for product optimization across specific performance metrics, but consumers judge which of those metrics are most important. As a result, detergent designers must allow an understanding of consumer behavior, and the factors that shape it, to guide their objectives in detergent design.

For instance, demographic shifts are a major driver of dishwashing preferences.



Dish washing preferences differ regionally. *Source: DISH issue 3*

The fast-paced lifestyles and eco-conscious values of Millennials and Generation Z have encouraged demand for energy-efficient dishwashers and premium detergents containing eco-friendly materials. These younger consumers prioritize performance and convenience alongside sustainability and are more willing than older generations to abandon brand loyalty and switch products if a detergent fails to deliver results.

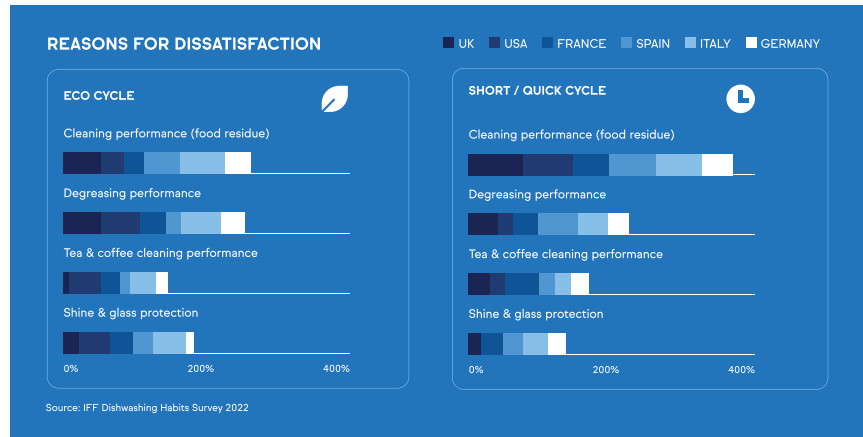
In addition to demographic variation, detergent format and wash cycle preference are highly regional. Across cultures, dishware and dish-care reflect tradition and history. When a dish is emptied following a meal how it is cleaned is rooted in custom. These cultural preferences impact the choice of dishwashing detergents, and the methods used to keep them clean.

Other regional variables, such as available dishwasher models, manufacturer recommendations and local regulators, can also influence which detergent formats are preferred and how they perform. In the EU, regulations mandate dishwashers start with the ECO program by default.

FINDING OPPORTUNITY IN CONSUMER CONTRADICTIONS

Globally, the top five reported concerns in dishwashing are:

- Powerful cleaning
- Sustainable formulation



Reasons for dissatisfaction with eco and quick cycles. *Source: DISH issue 3; 2022 survey*

- Does not need prewash
- Works in short cycle
- No residues/build-up

However, reported consumer preferences alone are poor benchmarks for detergent design objectives. What people say they want often diverges from what they actually do. These gaps reflect a mix of deep-rooted habits, long-held beliefs, and real-world tradeoffs. These often-unspoken contradictions are the true hot-spots of opportunity for innovation. Dishwashing technologies that successfully close gaps between a consumer's behavior and their values are most likely to shape enduring changes in detergent preference.

Tension between values and behaviors show up consistently across sustainability choices, appliance usage, and expectations of cleaning performance. For instance, across markets, expression of pro-sustainability values does not map cleanly to behavior.

While 80 percent say sustainability matters, more than half still routinely pre-wash their dishes. Meanwhile, 75 percent of consumers are interested in detergents designed for short cycles, yet they still select normal, auto or Eco as their main cycle of choice. These patterns illustrate a recurring dynamic: even when consumers want to make environmentally responsible choices, convenience and perceived reliability often win out.

Modern dishwashers offer cycles meant to balance convenience and sustainability, yet few options satisfy all priorities at once. For both eco and short cycles the top sources of dissatisfaction remain consistent worldwide: leftover food residue, poor degreasing, lingering tea and coffee stains, and insufficient shine or glass protection.

As a result, detergents formulated for improved sustainability that come with tradeoffs in performance are unlikely to sustain eco-friendly behavior. As an example, dish-

ADW Formats Performance Test

WASH CONDITIONS

IKW, GSL2, 45°C, 8'hold, 21°GH

TECHNOLOGIES

Protease, Amylase, Bleach



RETAILER BRAND
ALL IN ONE



RETAILER BRAND
CLASSIC



GLOBAL BRAND
HIGH TIER CAPSULE

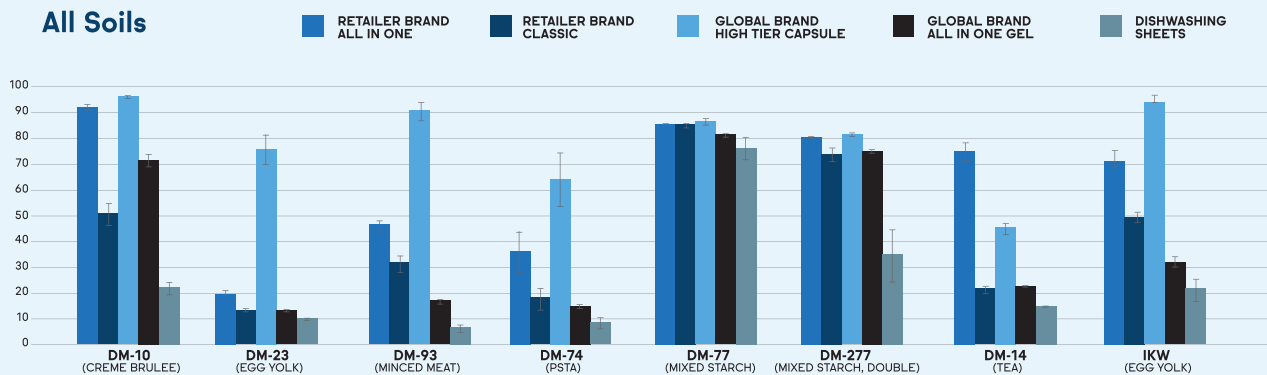


GLOBAL BRAND
ALL IN ONE GEL



DISHWASHING
SHEETS

All Soils



Detergent format performance across soil types. *Source: DISH issue 4*

washer sheets, which are slim, biodegradable, and waterless have emerged as a promising new format; however, the comparative performance of current formulations is likely to limit their popularity. Sheets have limited space to hold enzyme granules, which may make the product less effective on certain stains. Also, sheets have a low pH that may lower the performance of detergent-supporting enzymes.

We conducted a comparison test on an EU detergent sheet branded as tough on stubborn stains using protease (on egg yolk and minced

meat) and amylase (on pasta and mixed starch). The format demonstrated inferior cleaning performance compared to all-in-one tablets and pods. Future iterations on dishwasher sheets formulations may help them gain a more significant foothold in the detergent landscape and overcome performance limitations.

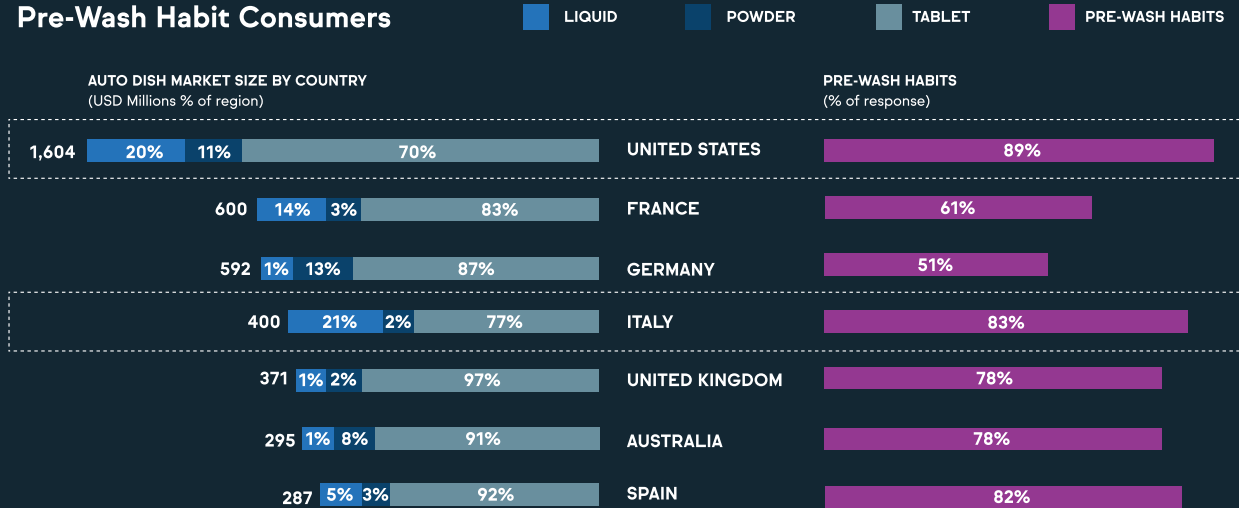
CONFRONTING THE DISTANCE BETWEEN BELIEF AND REALITY

Dish manufacturers who develop superior dishwashing solutions across performance

and sustainability metrics cannot just rely on data-backed evidence to drive changes in behavior. They must also invest in promoting awareness that dishes do not need to be pre-rinsed, and in addressing misconceptions around which formulations are sustainable and which are not.

For instance, there is a common misconception that gels are more sustainable than other detergents because they do not contain bleach. While gels are mostly bleach-free, liquids can contain up to 30 percent water compared to a tablet or unit dose which has about 6 percent.

Gels Are Popular with Pre-Wash Habit Consumers



Source: IFF Consumer Habits 2022, 2024

Gels are most popular where pre-wash habits are prevalent. *Source: DISH Issue 4*

Many consumers switch to gel detergents after a few frustrating experiences with powders or tablets failing to dissolve. Because these users typically pre-rinse their dishes, the gel appears successful effectively masking any performance gaps. In reality, the gel format fundamentally compromises cleaning power. Higher water activity and greater interaction between ingredients pose severe stability challenges for enzymes, leading to denaturation, autolysis, and a loss of activity. This combination of consumer habit and misconception explains why gels retain a 20 percent market share in the United States, despite clear research suggesting inferior sus-

tainability and performance. If brands can convince consumers to stop pre-rinsing, then consumers may become more likely to notice which detergents perform best.

REAL-WORLD IMPACT STARTS AT THE MOLECULAR LEVEL

Detergents that really do perform best use enzyme-based biotechnology. These

Detergents that really do perform best use enzyme-based biotechnology. These enzymes speed up and boost cleaning power.

enzymes speed up and boost cleaning power by breaking down insoluble molecules into soluble sub-components.

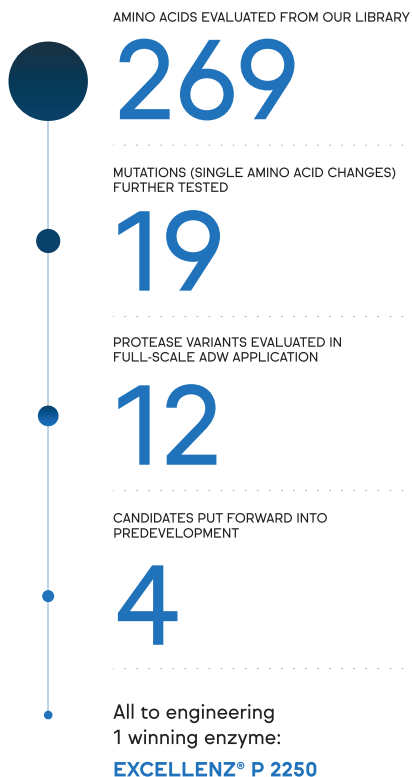
Creating a performance-boosting enzyme requires a complex, multi-step engineering process. Our ingredients optimize for needs such as long-term stability, cold-water washing, and chemical-based ingredients replacement using protein engineering techniques and AI and machine-learning tools. For example, to engineer the protease EXCELLENZ® P 2250, researchers evaluated 269 amino acid sequences, put four candidates into pre-development, tested 19 single-amino-acid mutations, and evaluated 12 variants in full-scale automated dishwasher

applications before finding the optimal formula to fight protein stains.

Another enzyme product, MARVELLENZ® 2000, is an optimized blend of protease and amylase, engineered to remove stains like starch, pasta, egg yolk, and minced meat. Crucially, this blend outperforms traditional standards even at low, energy-saving temperatures like 40°C and 45°C, effectively enabling consumers to use short cycles without sacrificing performance.

However, even the best enzyme is useless if it degrades before reaching the dishwasher. A major problem for formulators is preserving enzyme efficacy across product packaging and wash conditions. A technological solution to this problem is our proprietary ENZOGUARD® granulation technology. This innovation protects the enzymes with a layer that shields them from the degrading impacts of bleach and ambient humidity, ensuring prolonged stability and consistent cleaning over time. Even with a protective layer, enzymes must be optimized across real-world conditions.

Variables like cycle length, water hardness, detergent format and temperature alter



Protein engineering by the numbers
Source: DISH Issue 1

enzyme effectiveness, so developers must build targeted, high-performing solutions around real consumer conditions. It is not enough to know a biological product's chemical profile; developers must understand how it will perform inside a machine in someone's kitchen.

This requires applications testing that recreates the extremes of consumer con-

ditions. The industry needs a global network of applications labs to ensure that regional water conditions, appliance preferences, and common local food soils are all accounted for in the development process. To guarantee efficacy across conditions formulators manipulate water hardness during testing to simulate conditions ranging from soft Scandinavian water to the mineral-heavy water of the American Midwest and test detergents on over 10,000 specific soils across a variety of globally popular machine brands. During an application's test, pH and conductivity profiles are continuously and precisely measured throughout the entirety of a wash cycle.

Even when innovating at the molecular level, the difference between good and great is not a direct function of cleaning power. It is a result of how well the real-world concerns and realities of consumers are reflected in the enzymes that clean up after them.

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