(REFEREED RESEARCH)

SOIL RELEASING EFFECT OF CONCENTRATED DETERGENTS COMPARED WITH THE ORDINARY ONES

KONSANTRE DETERJANLARIN NORMAL DETERJANLARA KIYASLA KİR ÇIKARMA ETKİSİ

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ABSTRACT

Laundry detergents play a very important role in cleaning habits. Besides their efficiencies, their impacts on the environment determine their places on the market. Nowadays concentrated (ultra) detergents are popular. Decreased impact on the environment is a driving force behind the development of concentrated detergents. Concentrated formulas mean smaller containers, less water and more efficient transport in the environmental point of view. They are also good for the clothes' appearances, handle and the life of washing machines. Although the concentrated detergents are announced as consumer friendly, there are some questions on the consumers' minds. The consumers tend to accept more is more. The reason for them to use more detergent does not provide more soil releasing effects. The proper dosage is the key to get optimum results. In this study a comparison between two types of commercial detergents were made. One type was traditional and the other one was concentrated. The comparison was made by using standard stains and constant washing conditions except than wash temperatures and applying the recommendations for the amount of detergents to be used for the washing procedures.

Key Words: Detergent, Concentrated detergent, Soil removal, Laundering.

ÖZET

Çamaşır deterjanları temizlik alışkanlıklarında çok önemli bir rol oynamaktadırlar. Etkinliklerinin yanısıra, çevre üzerine etkileri de pazardaki yerlerini belirlemektedir. Bugünlerde konsantre (ultra) deterjanlar popülerdir. Konsantre deterjanların gelişiminin arkasında bulunan çevre üzerinde azaltılmış etkileri, itici bir güçtür. Konsantre formüller, çevre açısından daha küçük konteynerler, daha az su ve daha verimli nakliye işlemleri anlamına gelmektedirler. Ayrıca giysilerin görünümü, tutumu ve çamaşır makinelerinin ömrü için de avantajlıdırlar. Konsantre deterjanlar tüketici dostu olarak ilan edilmelerine karşın, tüketicilerin aklında bazı sorular bulunmaktadır. Tüketiciler daha çok miktarda kullanımın daha iyi olduğunu kabul etme eğilimindedirler. Daha fazla deterjan kullanma nedenleri, daha fazla kir çıkarma etkisi sağlamamaktadır. Optimum sonuçlar için uygun dozajda kullanım anahtar faktördür. Bu çalışmada, iki tip ticari deterjan grubu arasında bir karşılaştırma yapılmıştır. Birinci tip ürün grubu geleneksel, diğeri konsantre deterjandır. Kıyaslama, standart lekeler ve yıkama sıcaklığı hariç sabit yıkama koşulları kullanarak ve yıkama işlemleri için önerilen deterjan miktarları uygulanarak yapılmıştır.

Anahtar Kelimeler: Deterjan, Konsantre deterjan, Kir çıkarma, Yıkama.

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1. INTRODUCTION

During the life cycle of textile materials, they need to be cleaned by the consumers many times. Washing, bleaching, dry cleaning and stain removing are such kind of cleaning processes applied to the textile materials. Cleaning has an evolution. In the early years, glycerine soap was the mainstay of the cleaning industry. To prevent diseases and to spread cleaning habits, people insisted on concentrating upon usage of soaps. Over the years, the cleaning industry evolved and by 1953, there was a widespread use of detergents. Consumer's cleaning habits changed when automatic dishwasher powders, liquid laundry detergents, hand dishwashing soaps, all-purpose cleaning products, fabric softeners, and detergents with oxygen bleach were brought to market. At the same time, environmental issues begin to reveal. Extensive environmental research was conducted on cleaning product ingredients. The industry worked together to coin the term "biodegradable." There was growing concern about the environmental and human safety of household cleaning products near the end of the century. Lack of time was a key issue for the expanding work force. Rapid technological advancements in new appliances lead to new cleaning products in the marketplace (1).

The forces upon the technological improvements were not only the environmental and legal issues, but also the demands of the users. Today the expectations of consumers from detergents are different than the past. Cleaning materials with high efficiency and low cost are preferable, but besides these factors, multifunctional products attract more and more attention, day by day besides environmental friendly ones. The primary task of the detergents

is to remove soils and stains, but they do much more than that. They are designed to freshen, remove odours, and brighten fabrics as they clean. Another key detergent function is to hold soils and any dyestuffs from coloured fabrics, suspended in the wash water. This keeps soils and dyestuffs from being re-deposited back onto the cleaned clothes (2).

Detergents are the products that contain a surfactant and other ingredients to clean fabrics in the wash. Generally, the ingredients of the detergents determine the quality, end-use and prices of the products. The following are common ingredients used in laundry detergents. Not all products contain all ingredients.

The main constituents of the detergents are **surfactants.** They improve the wetting ability of water, loosen and remove soil with the aid of washing process, then emulsify, solubilise, or suspend soils in the wash bath until soils are washed away. **Builders** enhance or "build" the cleaning efficiency of the surfactant by inactivating water hardness minerals. **Enzymes** break down complex stains and soils, including protein-based stains (grass and blood) and starch-based stains common to many foods. They can also improve the appearance and handle of fabrics. **Polymers** help to capture and hold soils and dyestuffs, sending them down the drain to avoid re-depositing on washed fabrics. **Oxygen Bleach** maintains colour and whiteness and may be used with all fabrics. Generally it can be said that it is not only an ingredient, but also a system. **Softeners** reduce fabric friction or static electricity, and help to provide a soft, fluffy appearance for fabrics. **Stabilizers** maintain high-sudsing function, where suds level is an important indicator of cleaning power. They also help maintain stability of the product and its shelf life, especially the enzymes and oxygen bleach. **Preservative** substances used to protect against natural effects of product aging, e.g., decay, discoloration, oxidation, and bacterial attack. They can also protect colour and fragrance. **Solvents** prevent separation or deterioration of ingredients in liquid products. **Fragrances** provide pleasant scent to fabrics, plus cover the odours of the detergent and the soils in the washing solution. They are very important in some markets because they give the image of the cleanliness, too. **Colorants** added to lend individuality to the product, or dramatize a special additive contributing to product performance. Laundry detergents come in many forms, each having its own benefits. High efficiency (HE) detergents, liquid detergents, powder detergents, concentrated detergents (ultra detergents), combination detergents, fragrance or dye-free detergents, soap bars and single-use detergents are examples. They have different formulations and characteristics (1).

Concentrated detergents are very popular nowadays; they belong to a new generation of cleaning products. Concentrated laundry detergents have been in the market in one form or another since the 1960s. Sometimes called "ultra" products, these products offer the same cleaning properties as the old traditional detergents, but in less amounts and so help to protect the environment. The key factor is very important; the right amount of concentrated products which is less than the regular ones should be used. One of the main benefits of concentrated products is their lightened impact on the environment (3).Smaller bottles use less plastic which means less packaging to recycle, or less trash around and less impact on the environment. Smaller containers mean less fuel is needed to ship these products. Manufacturers use less water in detergent production which means reduced use of a very precious natural resource (4). Less petrochemical consumption and less C02 emissions of course are the main advantages for the environment (5). And, smaller detergent containers are easier to carry and store at home. They are perfect for those who must use a laundry mat or community laundry room (4). Also too much detergent can make the clothes stiff and dingy. Detergent overdose can shorten the life of the washing machines (3).

Concentrated powder detergents generally comprise a surfactant, a detergency builder, enzymes, a peroxygen compound bleach, and a manganese complex as effective bleach catalyst. Use of these catalysts can make the detergent powder more compact, i.e. reduce the pack volume, without loss of performance or even with a much better bleaching and washing powder (6).The trend of using concentrated detergents turned into an action in Europe at 2004 app. among 170 firms. The international Association for Soaps, Detergents and Maintenance Products undertook this mission. The main profits of these detergents for the consumers are:

Environmental point of view: Less chemical agents, less packaging materials, less energy consumption.

Consuming point of view: Good level of cleaning with fewer products, less waste packaging materials, washing at low temperatures, usage of less energy.

New type of detergents is formulated to be 1/3 more concentrated. On the products of Europe "3 kg=2 kg" is written. The calculations and estimates point out percentages of decrease as below:

- Energy consumption: 17 %
- Solid waste : 11 %
- Carbon emission : 18 %
- Environmental recoveries of 11-44 % per each washing would be expected (7).

By the late spring of 2008, a famous detergent producer (maker of many brand products) eliminated large detergent bottles and switch completely to concentrated versions of its detergents. The results of the switch of this company, purely from the perspective of the bottles' environmental impact, were calculated as below:

- 35% less water.
- 43% less plastic (equivalent to about 2 billion plastic shopping bags each year).
- Total packaging reduction equivalent to the municipal solid waste of 40,000 people per year (about 32,000 tons, according to Redbook's garbage data).

- Greenhouse-gas reduction equal to the annual emissions of 40,000 cars (that's as if 16,000 households gave up their average 2.5 cars) (7).

A concentrated detergent is typically far superior to traditional detergents because it does not contain any filler material, which makes it better for the clothes and less expensive per load of laundry. Filler material is never put into concentrated detergent, so sometimes consumers do not feel like they are getting as much product for their payment. However, the amount detergent that is needed per load of laundry is also much less, which results in long term savings. In traditional detergents filler material is put into the products to give customers the feeling that they are getting more for their payments. Unfortunately, this filler still has to be shipped just like the detergent, and as a result, the consumer will typically pay more in the long term because the companies pass those additional costs to the buyer. The other unfortunate aspect of filler material is that it stays in the clothes long after they are washed, and will give the clothes a dingy look over time. Concentrated detergent is pure and will not leave any residue behind in the washer or in the clothes.

The equivalent concentrated detergent can easily cut household laundry and cleaning costs in half. The additive that makes traditional detergents more expensive is actually the same thing that fades the clothes over time. These traditional detergents use a filler material, which is a marketing tool used by their respective corporations to give consumers the feeling that they are getting more product. The unfortunate truth is that while consumers are getting more products with these detergents and soaps, that extra product is not actually cleaning material. The other side effect of nonconcentrated detergents is the higher shipping costs that result and are also passed down to the consumer (9).

There are many factors affecting the soil removing performance of the detergents such as fabric type, water temperature, water hardness, wash load and type of the machine. Besides the detergent quality which is the most determining factor, soil removal was found to generally improve with increasing wash temperatures (10,11)

The doses of the detergents are important for the environment, cost control, life of the clothes and the washing machines. Most consumers are accustomed to using too much detergent, which is indirectly good for a manufacturer (more product used, more product sold). But it can be a vicious cycle: more soap means a longer rinse cycle and a lot less environmentally friendly (12).

So the recommended amounts of the detergent producers should be used. The detergents should be measured, shouldn't be poured. The detergent habits should be changed in order to improve the laundry results (3).

In this research, stain types, fabric type, water hardness, wash load and type of the machine were left constant, only the wash temperature was changed. The amounts of the commercial detergents were used as the recommendations of the detergent producers. The aim of this study is to clear the questions on the consumers' minds about the dosage of the concentrated detergents to be used and to compare the performances of both traditional and concentrated types according to their abilities to release soils.

2. METERIALS AND METHODS

2.1. Materials

Test fabrics used for this study were standard artificial stains and they were obtained from various producers. The test fabrics are 100 % cotton and the physical properties of the test fabrics are given in Table 1.

Table 1. The properties of test fabrics used for this study

Artificial Stain	Producer	Stain	gr/cm^2	Yarn/cm	
				Warp	Weft
AS9	CFT	Egg Yolk	170,4	30	24
AS10	CFT	Butterfat with colorant	171,4	30	24
AS12	CFT	Blackcurrant juice	172,8	30	24
E112	EMPA	Cocoa	251,6	38	21
E114	EMPA	Red Wine	215,6	36	21
W10D	WFK	Pigment-Sebum	171	29	27

Table 2. The list of detergent active parts for the stains

Artificial Stain	Stain	Detergent Active Part
AS9	Egg Yolk	General Detergency
AS10	Butterfat with colorant	Protease
AS12	Blackcurrant juice	General Detergency
E112	Cocoa	Amylase
E114	Red Wine	Bleach
W10D	Pigment-Sebum	General Detergency

The active parts of the detergents are different, so the kinds of the stains that they are active can also be different. The list of detergent active parts for the stains used in that study is given in Table 2:

The detergents used in washings were supplied from the market. 3 traditional and 3 concentrated detergents were used. The traditional-concentrated pairs of the detergents were of the same Trade Mark. Quantities of the detergents were chosen as the recommendations of the producers. The codes of the detergents and the quantities are given in Table 3.

Table 3. The codes and the quantities of the detergents

Product Name	Quantity(g)
X Detergent (X)	210
Y Detergent (Y)	225
Z Detergent (Z)	260
Concentrated X Detergent (XC)	150
Concentrated Y Detergent (YC)	150
Concentrated Z Detergent (ZC)	150

The composition of the detergents is given over the detergent boxes as below:

Cationic active agent, nonionic active agent, polycarboxylate and zeolite: below 5 %

Anionic active agent, oxygen based bleaching agent and zeolite : 5-15 %

Phosphate : 15-30 %

2.2. Methods

In order to determine the soil releasing effects of the concentrated detergents, washing habits of the consumers and the recommendations of the producers were taken into account. Home washing procedure and the amounts of the detergents written over the detergent boxes were applied. Washing processes were made in Arçelik 3650 SJ washing machine. The program used in washings was main washing of "cotton program". Temperatures for the washings were chosen as 40ºC and 60ºC. Loads per washing were prepared as 9 artificial standard stains and filler fabrics composed of 3 kg. of white towel and white knitted fabrics of cotton, all without optical brighteners. Every washing was made as 6 repeats. The hardness of the water used in washing was 20º F. The evaluations were made by a colour measurement device named "HunterLab UltraScan XE 460 nm Reflectance". Unwashed samples were accepted as references and under D65 light sources, the differences of remissions at 460 nm (ΔR) were measured. As the difference increases, the efficiency of the detergent increases. The colour measurement results were statistically evaluated by SAS program.

3. RESULTS AND DISCUSSION

Standard stains of 6 different types were used for each washing. Soil releasing performance of 3 different traditional detergents and their concentrated types were checked after washings of the stains at 40ºC and 60ºC by measurements made with HunterLab UltraScan XE 460 nm Reflectance. The differences of remissions at 460 nm (ΔR) at 40ºC are given at Tables 4 and 5. The differences of remissions at 460 nm (ΔR) at 60ºC are given at Tables 6 and 7.

Table 4. The differences of remissions at 460 nm for the stains washed with three types of traditional detergents at 40ºC

	ΔR Values		
Artificial Stains	**X**	**Y**	**Z**
AS9	22,9242	23,6408	22,0583
AS10	29,5767	29,9233	26,5883
AS12	24,4000	24,1908	22,8708
E112	27,559	25,186	19,371
E114	27,620	28,363	20,103
W10D	23,3242	23,1717	22,0767

Table 5. The differences of remissions at 460 nm for the stains washed with three types of concentrated detergents at 40ºC

	ΔR Values		
Artificial Stains	**XC**	**YC**	**ZC**
AS9	23,9442	21,7925	20,3983
AS10	26,3750	29,9975	27,8567
AS12	23,8917	24,1383	21,0583
E112	29,546	28,884	20,748
E114	25,801	26,452	16,278
W10D	23,7992	22,0483	20,0917

Table 6. The differences of remissions at 460 nm for the stains washed with three types of traditional detergents at 60ºC

	ΔR Values		
Artificial Stains	**X**	**Y**	**Z**
AS9	24,6567	25,8783	23,6117
AS10	30,6742	28,8150	28,3550
AS12	25,3467	24,5275	23,6867
E112	34,974	26,570	20,066
E114	38,7633	31,7600	31,4400
W10D	26,3550	29,8633	23,8717

Table 7. The differences of remissions at 460 nm for the stains washed with three types of concentrated detergents at 60ºC

	ΔR Values		
Artificial Stains	**XC**	**YC**	**ZC**
AS9	27,0442	26,0575	25,0817
AS10	29,6575	31,1892	27,4408
AS12	27,2983	26,4733	23,2275
E112	35,732	36,037	23,103
E114	31,2983	34,5983	26,8108
W10D	29,6567	27,2183	27,5408

Table 8. Statistical evaluations and soil releasing performances of the detergents “X “and “XC” at 40°C

	ΔR Values and Statistical Evaluations				
Artificial Stains	LSD	(XC)	(X)	(XC)	(X)
AS9	1,4779	23,9442	22,9242	A	A
AS10	0,8013	26,3750	29,5767	B	A
AS12	1,266	23,8917	24,4000	A	A
E112	2,8662	29,546	27,559	A	A
E114	3,2482	25,801	27,620	A	A
W10D	1,8054	23,7992	23,3242	A	A

XC=X

Table 9. Statistical evaluations and soil releasing performances of the detergents “X “and “XC” at 60°C

	ΔR Values and Statistical Evaluations				
Artificial Stains	LSD	(XC)	(X)	(XC)	(X)
AS9	1,5718	27,0442	24,6567	A	B
AS10	1,2026	29,6575	30,6742	A	A
AS12	1,0378	27,2983	25,3467	A	B
E112	2,9408	35,732	34,974	A	A
E114	1,1192	31,2983	38,7633	B	A
W10D	1,6529	29,6567	26,3550	A	B

XC≥X

The statistical evaluations of the soil releasing performances for the detergents “X “and “XC” at 40°C and 60°C are given in Tables 8 and 9, the results for the detergents “Y “and “YC” at 40° C and 60°C are given in Tables 10, 11 and the results for the detergents “Z” and “ZC” at 40°C and 60°C are given in Tables12 and 13.

As the result of soil releasing tests for the X-XC pair performed at 40ºC, traditional (X) and concentrated (XC) detergents were equal except than the AS10 stain. For this stain, the enzyme part of the detergent was active and the concentrated product showed less performance than the traditional one and the difference was statistically important.

As the result of soil releasing tests for the X-XC pair performed at 60ºC, concentrated detergent (XC) was equal or better than traditional (X) one. As the wash temperature increased, for AS10 and E112 stains, the enzyme part of the detergent was active and both of the products showed better performance. In manner of general detergency, the concentrated product showed better performance than the traditional one and the difference was statistically important.

Table 10. Statistical evaluations and soil releasing performances of the detergents "Y "and "YC" at 40°C

	ΔR Values and Statistical Evaluations				
Artificial Stains	LSD	(YC)	(Y)	(YC)	(Y)
AS9	1,8741	21,7925	23,6408	A	A
AS10	0,9476	29,9975	29,9233	A	A
AS12	1,6166	24,1383	24,1908	A	A
E112	2,5727	28,884	25,186	A	B
E114	3,1403	26,452	28,363	A	A
W10D	2,0171	22,0483	23,1717	A	A

YC=Y

Table 11. Statistical evaluations and soil releasing performances of the detergents "Y "and "YC" at 60°C

	ΔR Values and Statistical Evaluations				
Artificial Stains	LSD	(YC)	(Y)	(YC)	(Y)
AS9	1,6052	26,0575	25,8783	A	A
AS10	1,2852	31,1892	28,8150	A	B
AS12	1,6945	26,4733	24,5275	A	B
E112	3,9707	36,037	26,570	A	B
E114	0,7922	34,5983	31,7600	A	B
W10D	2,0949	27,2183	29,8633	B	A

YC>Y

Table 12. Statistical evaluations and soil releasing performances of the detergents "Z "and "ZC" at 40°C

	ΔR Values and Statistical Evaluations				
Artificial Stains	LSD	(ZC)	(Z)	(ZC)	(Z)
AS9	1,5799	20,3983	22,0583	B	A
AS10	1,1199	27,8567	26,5883	A	B
AS12	1,4806	21,0583	22,8708	B	A
E112	1,9711	20,748	19,371	A	A
E114	3,7322	16,278	20,103	B	A
W10D	1,6418	20,0917	22,0767	B	A

Z>ZC

Table 13. Statistical evaluations and soil releasing performances of the detergents "Z "and "ZC" at 60°C

	ΔR Values and Statistical Evaluations				
Artificial Stains	LSD	(ZC)	(Z)	(ZC)	(Z)
AS9	1,188	25,0817	23,6117	A	B
AS10	0,877	27,4408	28,3550	B	A
AS12	1,1734	23,2275	23,6867	A	A
E112	2,7669	23,103	20,066	A	B
E114	1,582	26,8108	31,4400	B	A
W10D	1,5673	27,5408	23,8717	A	B

ZC=Z

As the result of soil releasing tests for the Y-YC pair performed at 40ºC, traditional (Y) and concentrated (YC) detergents were equal. Except for E112 stain for which the enzyme part of the detergent was active, the concentrated product showed better performance than the traditional one and the difference was statistically important.

As the result of soil releasing tests for the Y-YC pair performed at 60ºC, the concentrated product showed better performance than the traditional one and the difference was statistically important.

As the result of soil releasing tests for the Z-ZC pair performed at 40ºC, the tendency of soil releasing for this product pair was different than the previous ones. X-XC and Y-YC pairs gave similar results to each other at 40ºC that the concentrated products were equal or better than the traditional ones and the differences were statistically important. For Z-ZC pair, the traditional product showed better performance than the concentrated one except than AS10 and E112 stains for which the enzyme part of the detergents were active; the concentrated product was equal or better than traditional one.

As the result of soil releasing tests for the Z-ZC pair performed at 60ºC, both of the products showed equal performances.

4. CONCLUSION

The research and development works of detergent producers improve the properties of the detergents in terms of usage and environment. The concentrated detergents are new in the market and the recommendations about the dosages of the detergents are striking, approx. 2/3 of the traditional ones.

Normally the soil releasing effect of the detergents increases as the quantity of the detergent increases, so the consumers increase the amount of the detergent to remove the heavy soils. It is obvious that better effects are obtained by concentrated detergents in the low amounts. The consumers should change their habits about this issue because more detergent does not mean always more washing effect in home type washing process. It is also very important for the environment to use concentrated products in proper dosages because of the decreasing amounts of chemical agents, packaging materials, energy consumption, water pollution and carbon emission

In this study, the soil releasing effects of the traditional and concentrated detergents were compared against various types of standard artificial stains. Two pairs of concentrated detergents (X-XC and Y-YC) showed the equal performance with the traditional ones at 40ºC, but they are better than the traditional ones at 60ºC. The other detergent pair (Z-ZC) gave some different results both at 40°C and 60°C. At 40°C, the traditional product was better than the concentrated one except than the washing tests with the enzymatic stains. At 60ºC, both of the detergents (Z-ZC) showed equal performances. The main reason for these performance differences of the product pair (Z-ZC) can be the low price of this group, so the quality level may be different than the others.

It is always very important to read the recommendations, instructions over the packages of concentrated detergents as every kind of product. The usage of right amount of concentrated detergent results many advantages in environmental and consuming points of view.

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