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## "What 'zyme is it?": A comparison of the effectiveness of various enzyme cleaners on soft contact lenses

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### Recommended Citation

Cheung, Kuen and Masaki, Melanie Joy, ""What 'zyme is it?": A comparison of the effectiveness of various enzyme cleaners on soft contact lenses" (1999). *College of Optometry*. 1270.  
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## **"What 'zyme is it?": A comparison of the effectiveness of various enzyme cleaners on soft contact lenses**

### **Abstract**

A clinical study was conducted to determine the cleaning efficacy of soft contact lens enzymatic cleaners available on the market, including Alcon's new one-drop wonder, SupraClens. Soft contact lenses from each of the four CL groups were coated with a 0.1% artificial lysozyme solution before being enzymatically cleaned by six commonly used protein removers. The treated lenses were dehydrated and analyzed for remaining protein deposits. Allergan's Ultrazyme was not only able to remove protein from each of the four types of lenses, but was able to dissolve the protein as well. It was also noted the liquid enzyme removed protein as effectively as the tablet forms. The study also evaluated the cost-efficiency of the enzymatic cleaners tested. Alcon's Opti-Zyme enzymatic cleaner and CIBA Vision's Unizyme enzymatic cleaner were found to be the best buys over a years time. Alcon's SupraClens came out to be one of the most expensive, although for contact lens wearers with faster protein build-up times, it might be more beneficial in terms of decreasing discomfort, ocular infections, and allergic reactions.

### **Degree Type**

Thesis

### **Degree Name**

Master of Science in Vision Science

### **Committee Chair**

Patrick J. Caroline

### **Subject Categories**

Optometry

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“WHAT ‘ZYME IS IT?”

A COMPARISON OF THE EFFECTIVENESS OF VARIOUS ENZYME  
CLEANERS ON SOFT CONTACT LENSES

By

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MELANIE JOY MASAKI

A thesis submitted to the faculty of the  
College of Optometry  
Pacific University  
Forest Grove, Oregon  
for the degree of  
Doctor of Optometry  
May, 1999

Adviser:  
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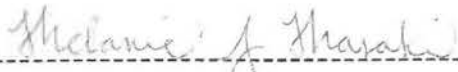
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A

## **Biographical Sketch**

**Kuen Cheung**, born in London, England, immigrated to Edmonton, Alberta, Canada at age 12. He attended the University of Alberta and completed a B.Sc. with specialization in microbiology. Before entering Pacific University College of Optometry in 1995, he also completed a M.Sc. with specialization in food and dairy microbiology at Oregon State University in Corvallis, Oregon. During his course of optometric study, Mr. Cheung was a member of the Beta Sigma Kappa International Honor Society and a class liaison for intramural sports. Upon graduation in May 1999, Mr. Cheung will be moving to Vancouver, British Columbia, Canada, where he wishes eventually to practice.

**Melanie J.K. Masaki**, a native of Honolulu, Hawaii, graduated from the University of Washington with a B.S. in zoology. During her years in optometry school, Melanie was a member of the Beta Sigma Kappa International Honor Society, Phi Theta Upsilon optometric fraternity, and Amigos member. Upon graduation, she plans on becoming a private practitioner wherever her heart may lead her. She would like to thank her parents for all their love and support throughout the years.

## **Abstract**

A clinical study was conducted to determine the cleaning efficacy of soft contact lens enzymatic cleaners available on the market, including Alcon's new one-drop wonder, SupraClens. Soft contact lenses from each of the four CL groups were coated with a 0.1% artificial lysozyme solution before being enzymatically cleaned by six commonly used protein removers. The treated lenses were dehydrated and analyzed for remaining protein deposits. Allergan's Ultrazyme was not only able to remove protein from each of the four types of lenses, but was able to dissolve the protein as well. It was also noted the liquid enzyme removed protein as effectively as the tablet forms. The study also evaluated the cost-efficiency of the enzymatic cleaners tested. Alcon's Opti-Zyme enzymatic cleaner and CIBA Vision's Unizyme enzymatic cleaner were found to be the best buys over a years time. Alcon's SupraClens came out to be one of the most expensive, although for contact lens wearers with faster protein build-up times, it might be more beneficial in terms of decreasing discomfort, ocular infections, and allergic reactions.

**Key Words:** Cleaning efficacy, soft contact lens enzymatic cleaners, protein removers, liquid enzyme, cost-efficiency

## Introduction

The buildup of protein deposits on contact lenses have caused contact lens wearers a number of difficulties such as discomfort, decreased visual acuity, allergic reactions and even adverse reactions such as giant papillary conjunctivitis (GPC).<sup>(1-3,5,7)</sup> The major component of these protein deposits come from tear lysozyme, while other ocular proteins such as lactoferrin, albumin and glycoproteins make up the minor constituents. <sup>(1,2)</sup>

Although both soft lenses and rigid gas permeable contact lenses have shown a tendency to develop protein deposits during wear time, it seems that proteins have an apparent preferential adherence to soft contact lenses due to the materials used in their manufacturing. <sup>(2)</sup>

Currently, there are three enzyme preparations approved by the Federal Department of Agriculture (FDA) for the removal of protein deposits found on soft contact lenses; papain, pancreatin, and subtilisin. <sup>(2)</sup> These enzymes have been proven to be very effective in catalyzing certain chemical reactions which attack protein molecules and break them down into smaller soluble fragments that are more easy to remove. Papain, derived from the papaya plant, was the first contact lens enzymatic cleaner approved for use in the United States. <sup>(2)</sup> Although demonstrated to be an effective cleaner for soft contact lenses, it has a relatively high incidence of causing ocular discomfort and allergic reactions. <sup>(5,7)</sup> Pancreatin, derived from the hog pancreas, contains a mixture of enzymes. They include a protease, a lipase, and an amylase. Comparative studies have shown pancreatin to be as equally effective as papain in removing protein deposits from soft contact lenses, <sup>(1,5)</sup> and is claimed to cause less ocular discomfort and allergic reactions. Subtilisin is a proteolytic enzyme produced by the bacterium, *Bacillus licheniformis*. It's advantages are minimal adsorption to soft contact lens surfaces, a longer peak action time which allows cleaning to continue overnight, and minimal evidence of subsequent ocular irritation.<sup>(5)</sup>



In the past all enzymes have come in the form of tablets. Their recommended usage is once a week for the removal of protein deposits found on soft contact lenses. Recently, Alcon Laboratories introduced SupraClens, the first FDA approved enzyme cleaner in a solution. It is designed to be used with the Alcon Opti-Free cleaning system and instead of the recommended weekly use of enzyme tablets, it is recommended daily, by adding one drop to each lens well before overnight storage. It is sold in a plastic squeeze bottle, that gives consumers thirty days of cleaning power.

The goal of this study was to determine the most effective enzyme cleaner on the market today. The efficacy of SupraClens was also to be compared to the current standard of weekly enzyme tablets. A breakdown of the cost-efficiency of each enzyme cleaner was of interest as well, since SupraClens is an everyday cleaner compared to enzyme tablets which are only used once a week.

## Materials and Methods

An artificial 0.1% tear lysozyme solution was prepared using the Allergan protocol to in-vitro coat hydrophilic contact lens. The solution consisted of Sigma-Aldrich lysozyme powder grade I, sodium chloride, dibasic sodium phosphate and monobasic sodium phosphate. (see Table 1) Five mLs of solution were prepared for each lens to be coated.

Insert Table 1

Five mLs of the 0.1% artificial lysozyme solution were dispensed into clean lens vials. Ten -2.00 D lens from each of the four contact lens groups (see Table 2) were turned inside out and placed (one lens per vial) concave side up and completely submerged in the lysozyme solution. Vials were capped with rubber tops and crimped with aluminum seals, before being placed into an AOSeptor rack. The rack was placed into a Bausch & Lomb AOSeptor pan filled with three quarts of distilled water. The lenses were incubated for seven heat cycles (one hour per cycle) and allowed to cool to room temperature overnight.

Insert Table 2

The contact lenses were removed from their vials with a rubber tipped tweezer, rinsed gently with saline (to wash away unbound lysozyme), and inspected for uniform coating. Any lens lacking a uniform coat of protein was not used in the study. One lens from each of the four lens groups was placed in each of six enzyme cleaner solutions. (see Table 3) An additional lens from each group was placed in a vial of distilled water to act as a control.

Insert Table 3

The longest minimum soaking time of four hours was used as the soaking time for all of the solutions. All of the enzyme solutions were prepared according to the directions on package inserts. (see Table 4)

Insert Table 4

After four hours, the contact lenses were removed from the enzyme solutions and placed into special dehydrating cases for 48 hours. The cases allowed the contact lenses to retain their shape while drying the remaining protein onto the lens surface. Five 1mm diameter holes were pierced in a circular pattern into the tops of plastic contact lens cases.

The dried contact lenses were examined under a dissection scope at 10 X magnification. Remaining protein deposits were quantified using a four point scale: "1" having a full coat of protein and "4" having no protein at all. (see Table 5)

#### Insert Table 5

Photographs of the contact lenses were taken using the attachable Polaroid camera with contact lenses against a black background.

In order to compare the cost-efficiency of the enzyme cleaners, prices were obtained from five chain stores/supermarkets. The cost per tablet/drop, cost per month, and the cost per year were then calculated.

## Results

Using the four-point scale, the enzymed lenses were evaluated for protein deposition and the results were summarized in Table 6.

Insert Table 6

Photo 1 shows a Grade 1 lens, depicting a full protein coat.

Insert Photo 1

Photo 2 shows a Grade 2 lens, depicting slight edge lift of the protein coat.

Insert Photo 2

Photo 3 shows a Grade 3 lens, depicting a minimal protein coat.

Insert Photo 3

Photo 4 shows a Grade 4 lens, depicting complete protein coat removal.

Insert Photo 4

Table 7 shows the cost of each enzymatic cleaner used in the study. Prices were obtained from various drug stores/supermarkets.

Insert Table 7

Using data from Table 7, the cost-efficiency of each enzyme cleaner was calculated and summarized in Table 8.

Insert Table 8

Graphs 1-4 graphically compare the effectiveness of each enzyme on the four FDA-approved groups of contact lenses.

## Discussion

The results of the study indicate that while most of the enzyme cleaners were effective in removing the lysozyme from the contact lenses, Allergan's Ultrazyme was the only one to have dissolved the protein completely. No fragments were left on any of the four types of contact lenses, and no fragments were found remaining in the surrounding enzyme solution.

Twenty percent of the contact lenses in the other enzymes experienced an "edge lift", where only the edges of the protein coat had been freed from the contact lens surface. Forty percent of the protein coats "slid off", meaning that they were unattached to the contact lens, but remained intact in the solution, and twenty percent of the contact lenses were still fully coated. The type of proteolytic ingredient was not deemed to be a determining factor in enzyme efficacy, and no difference was noted between the tablet and liquid forms.

Group II contact lenses appeared more resistant to enzyme activity than the other three groups, while Group I lenses appeared the least resistant. This could possibly mean that contact lenses containing non-ionic polymers or having a lower water content are more susceptible to enzyme cleavage. However, we will leave that for another thesis to answer.

Cost-efficiency-wise, Alcon's Optizyme and CIBA Vision's Unizyme were found to be the best buys for the prices obtained. The liquid enzyme, SupraClens, was found to be one of the most expensive, primarily because of its daily recommended use. However, for contact lens wearers who have an increased amount of protein in their tears and who experience faster protein buildup, a daily enzyme cleaner would benefit them better in the long run.

Table 1 Artificial Tear-Lysozyme Ingredients

mg/ml	Ingredient
1.00	Lysozyme (egg white)
2.80	Sodium Chloride (USP)
11.50	Sodium Phosphate (Dibasic, Anhydrous)
2.30	Sodium Phosphate (Monobasic, Monohydrate)

Table 2 FDA Approved Contact Lens Groups

Group	Water Content	Description	Contact Lens Used
I	low H <sub>2</sub> O, <50%	non-ionic polymer	Bausch & Lomb Sequence II
II	high H <sub>2</sub> O, >50%	non-ionic polymer	Wesley-Jessen Precision UV
III	low H <sub>2</sub> O, <50%	ionic polymer	Ocular Science ProActive 55
IV	high H <sub>2</sub> O, >50%	ionic polymer	Johnson & Johnson Acuevue

Table 3. Enzymatic Cleaner Characteristics

Name	Company	Active Enzyme Ingredient	Form
Opti-Free SupraClens Daily Protein Remover	Alcon	Pancreatin	Solution
Opti-Zyme Enzymatic Cleaner Especially for Sensitive Eyes	Alcon	Pancreatin	Tablet
Complete Weekly Enzymatic Cleaner	Allergan	Subtilisin A	Tablet
Ultrazyme Enzymatic Cleaner	Allergan	Subtilisin A	Tablet
ReNu One-Step Enzymatic Cleaner	Bausch & Lomb	Subtilisin A	Tablet
Unizyme Enzymatic Cleaner	CIBA Vision	Subtilisin A	Tablet



Table 4 Enzymatic Cleaner Soaking Directions

Name	Directions	Recommended Soaking Solution	Recommended Soaking Time
Opti-Free SupraClens Daily Protein Remover	1 drop per CL case side	Opti-Free Express Soln.	4 hrs - overnight
Opti-Zyme Enzymatic Cleaner Especially for Sensitive Eyes	1 tablet per vial	Opti-Free Express Soln.	15 mins - 12 hrs
Complete Weekly Enzymatic Cleaner	1 tablet per CL case side	Complete Multi-Purpose Soln	15 mins - overnight
Ultrazyme Enzymatic Cleaner	1 tablet in case	Ultra Disinfecting Soln	2 hrs - overnight
ReNu One-Step Enzymatic Cleaner	1 tablet per vial	ReNu All-In-One MP Soln	4 hrs - 12 hrs
Unizyme Enzymatic Cleaner	1/2 tablet per vial	Quickcare Multi-Purpose Soln	10 mins - overnight

Table 5 Four-Point Residual Protein Grading Scale

Grade	Description
1	Fully Coated
2	Edge Lift
3	Slid Off
4	Clear/Dissolved

Table 6. Staged Residual Protein and Enzyming

Name	Contact Lens		Groupings	
	I	II	III	IV
Opti-Free SupraClens Daily Protein Remover	3	1	2	3
Opti-Zyme Enzymatic Cleaner Especially for Sensitive Eyes	3	1	2	3
Complete Weekly Enzymatic Cleaner	2	1	1	3
Ultrazyme Enzymatic Cleaner	4	4	4	4
ReNu One-Step Enzymatic Cleaner	3	2	3	1
Unizyme Enzymatic Cleaner	3	3	3	2
Control	1	1	1	1

PHOTO 1

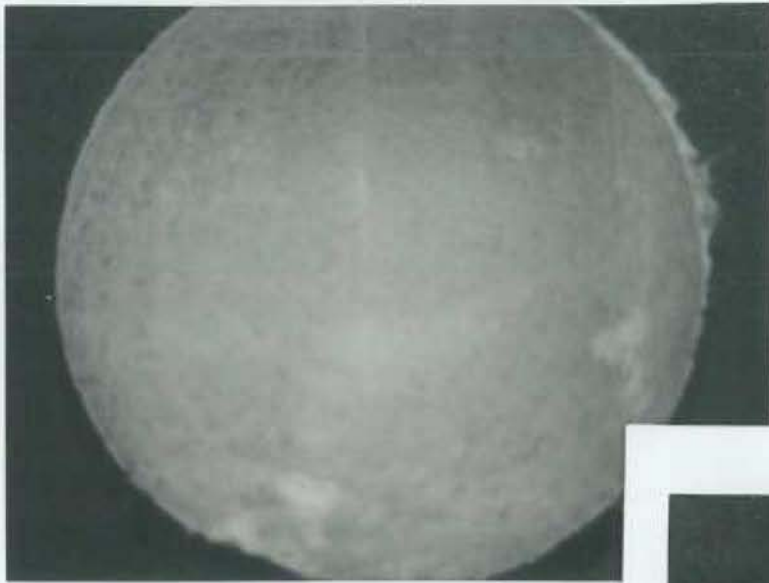


PHOTO 2



PHOTO 3



PHOTO 4

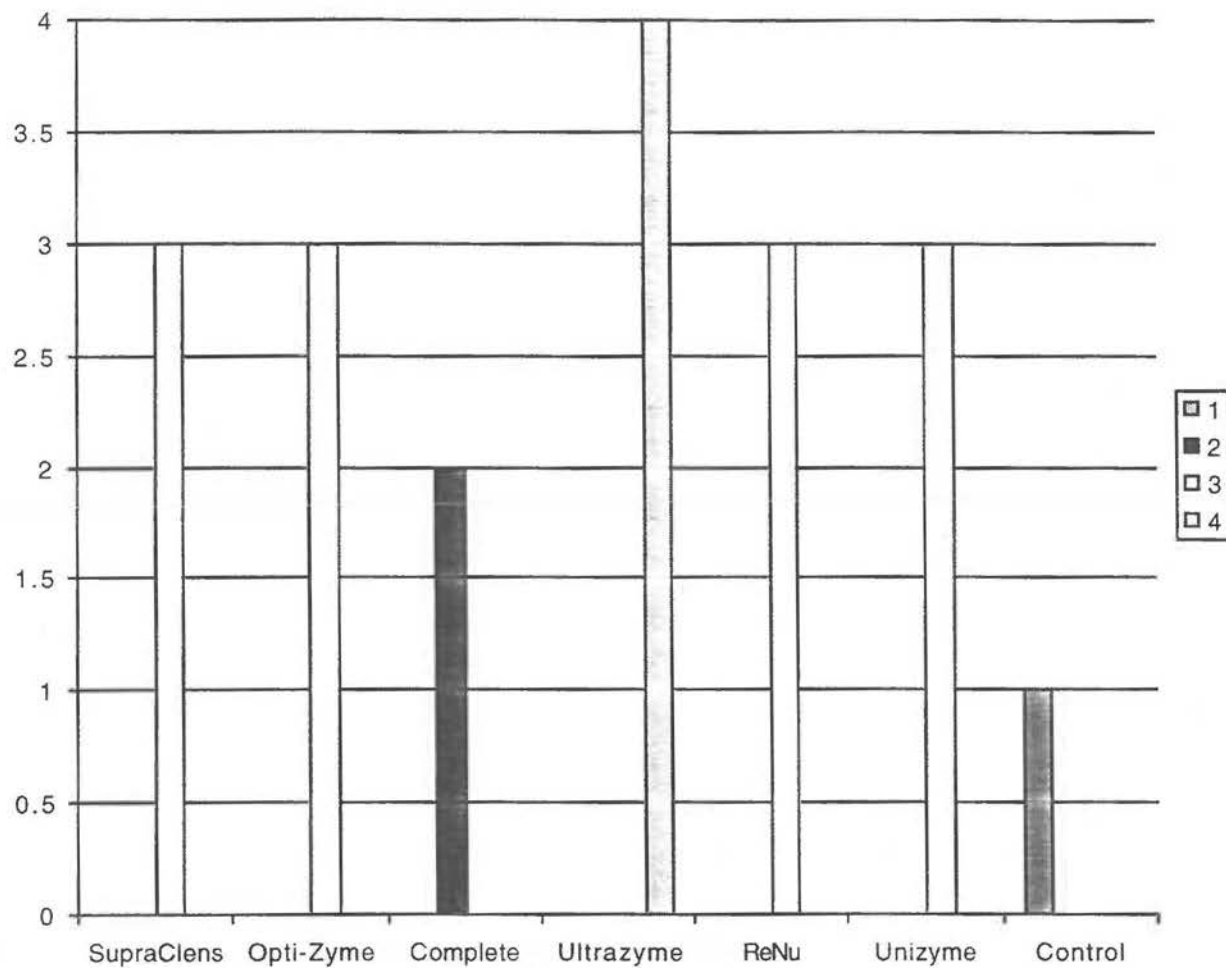


Table 7. Enzymatic Cleaner Costs

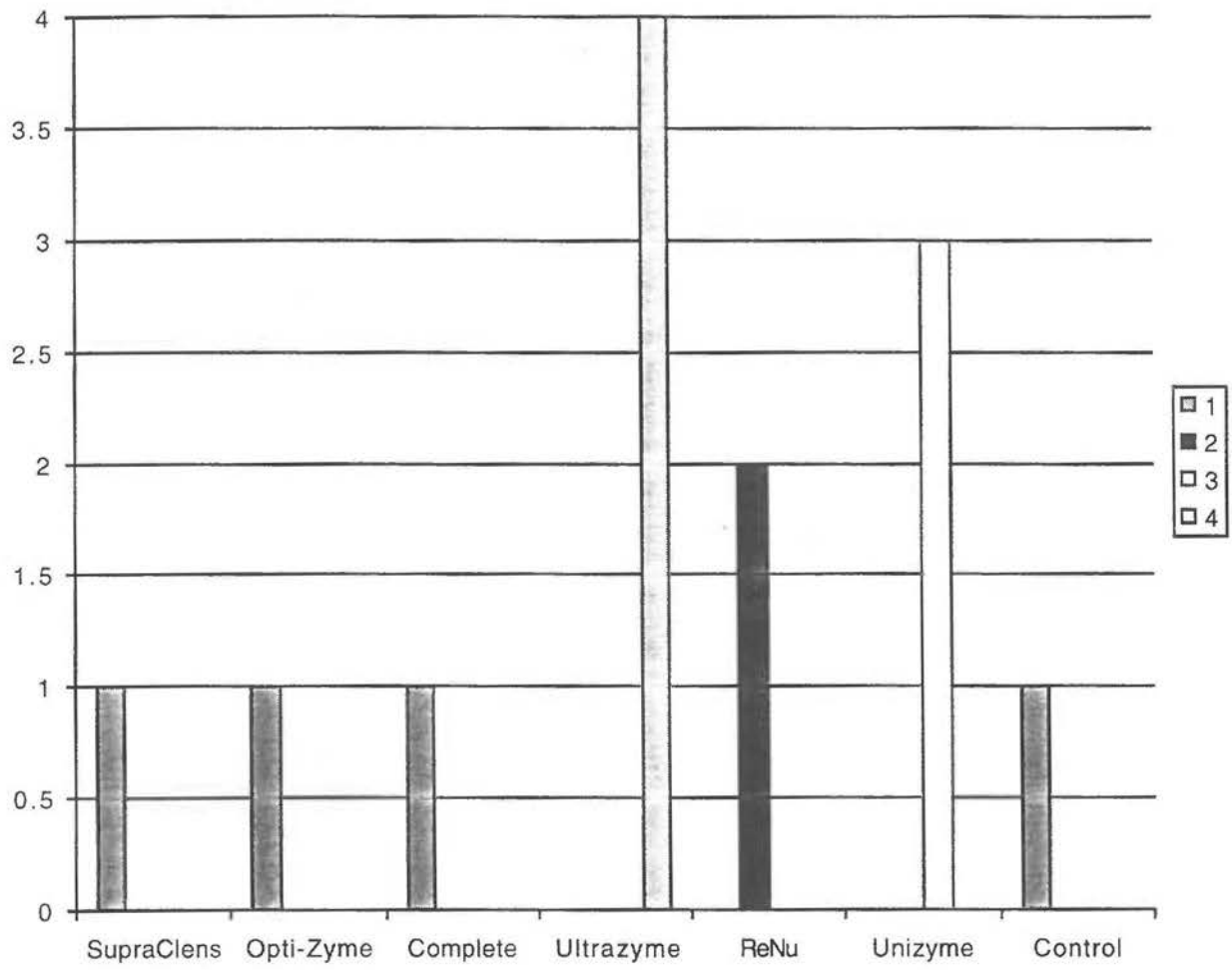
Name	Company	Amount	Fred Meyers	Safeway	Target	Rite-Aid	Costco
Opti-Free SupraClens Daily Protein Remover	Alcon	30 days	\$ 5.29	\$ 5.59	\$ 5.29	\$ 5.89	
		60 days					\$ 6.99
Opti-Zyme Enzymatic Cleaner Especially for Sensitive Eyes	Alcon	24 tablets	\$ 8.79	\$ 9.49	\$ 9.49	\$ 10.29	
		36 tablets	\$ 11.99	\$ 12.59			
		56 tablets					\$ 11.49
Complete Weekly Enzymatic Cleaner	Allergan	8 tablets	\$ 4.69	\$ 4.99	\$ 4.14	\$ 5.29	
Ultrazyme Enzymatic Cleaner	Allergan	5 tablets	\$ 6.49				
		10 tablets		\$ 9.99	\$ 9.09	\$ 10.39	
		20 tablets	\$ 14.49	\$ 14.99	\$ 14.19	\$ 15.29	
ReNu One-Step Enzymatic Cleaner	Bausch & Lomb	8 tablets					
		16 tablets	\$ 5.39	\$ 5.49	\$ 7.89	\$ 5.29	\$ 6.49
Unizyme Enzymatic Cleaner	CIBA Vision	12 tablets	\$ 7.99	\$ 8.29	\$ 6.85	\$ 8.39	



Graph 1 Protein Remaining on Group 1 Contact Lenses

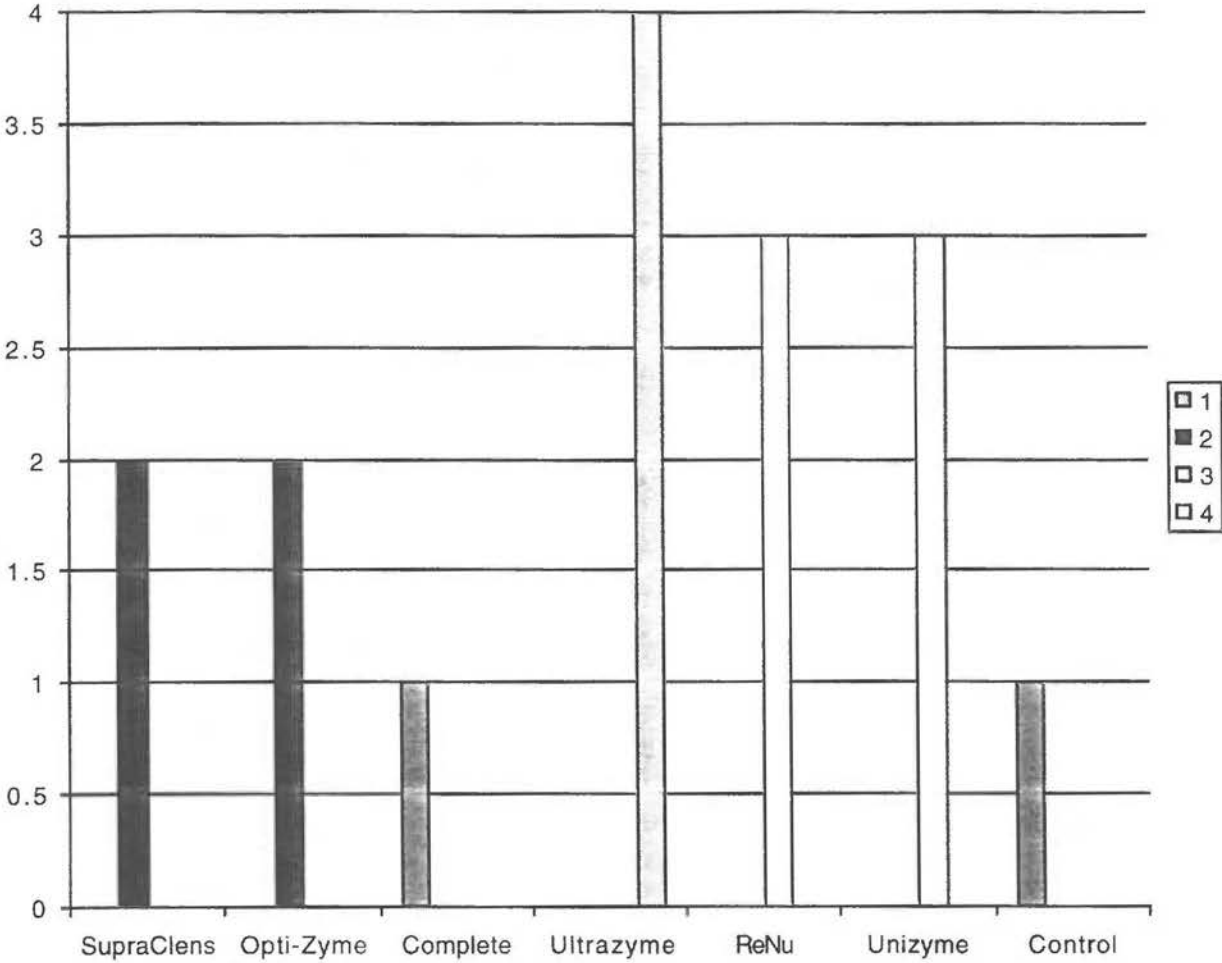


Graph 2 Protein Remaining on Group 2 Contact Lenses

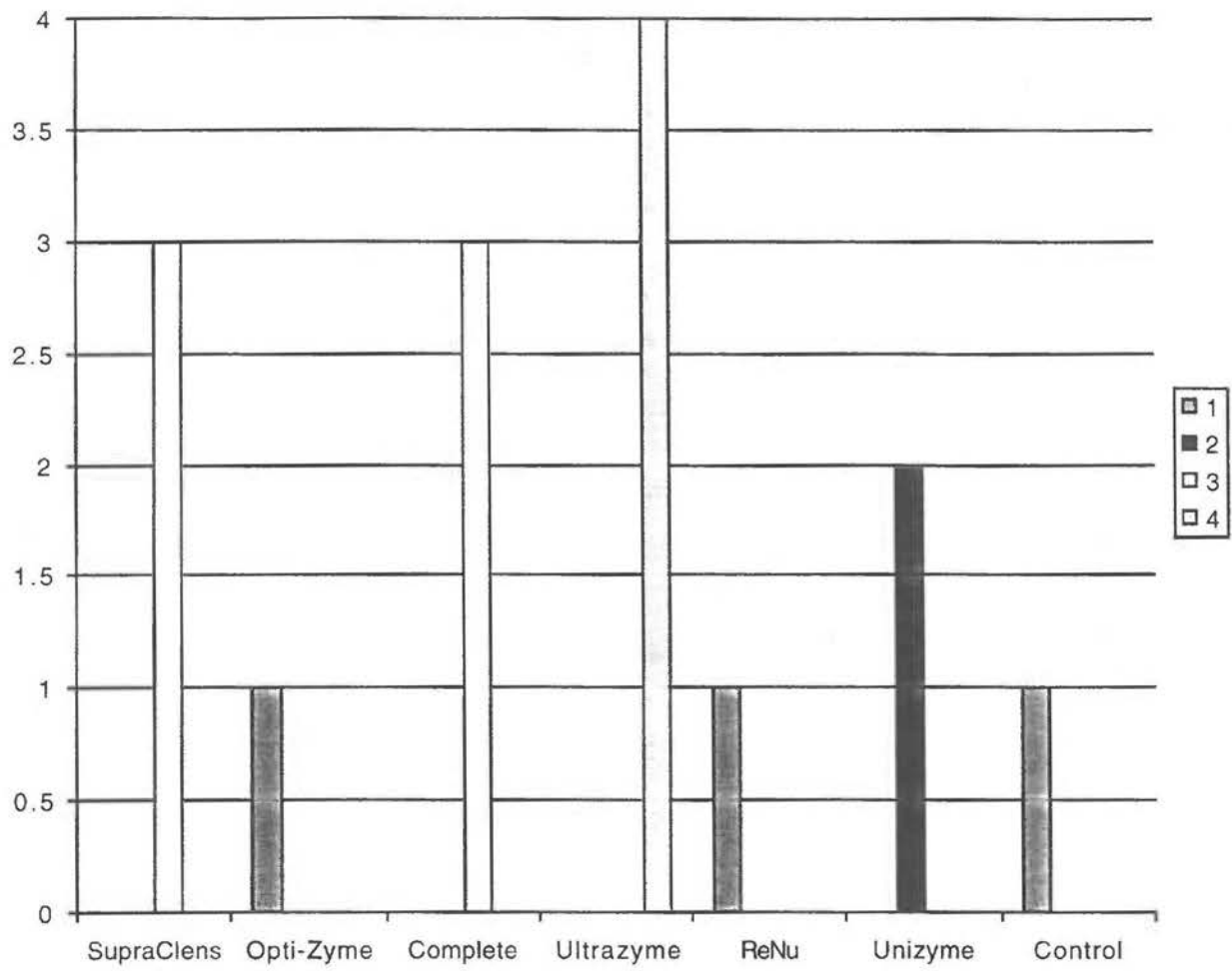




Graph 3 Protein Remaining on Group 3 Contact Lenses



Graph 4 Protein Remaining on Group 4 Contact Lenses



## **Acknowledgments**

The authors would like to thank Joe Vehige from Allergan for supplying the in-vitro protocol for coating hydrophilic contact lenses. Appreciation goes out to Pacific University's College of Optometry for donating the study contact lenses and for allowing full use of their facilities and equipment. Last, but not least, a huge thank you to Patrick Caroline for his advice and guidance throughout this thesis.

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