Wisconsin Institute for Sustainable Technology
College of Natural Resources
University of Wisconsin-Stevens Point

Fatty Acid and Grease Removal in Wastewater

QWIK-ZYME L STUDY

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Study Summary

- Within 27 hours, Qwik-Zyme L produced a reduction of every FOG sample by at least 83%
- Within that 27 hour time period, Qwik-Zyme L outperformed the control by an average of 36.7% (the largest margin being 70.2% and the smallest being 15.1%)
- The average removal rate of FOG for Qwik-Zyme L was 94.4% versus the control at 57.7%
- For COD removal, Qwik-Zyme L removed on average 335.5 ppm whereas the control removed on average 315.3 ppm
- Qwik-Zyme L outperformed the control for COD removal on average by 20.2 ppm
- In all the fat sources tested, the addition of the Qwik-Zyme L biocatalyst aided in the removal fatty acids from wastewater
- Additionally, Qwik-Zyme L specifically increased the rate of fatty acid removal during the first hours of treatment

Within

27Hrs

Qwik-Zyme L Reduced Fog Samples by at least

83%

Qwik-Zyme L

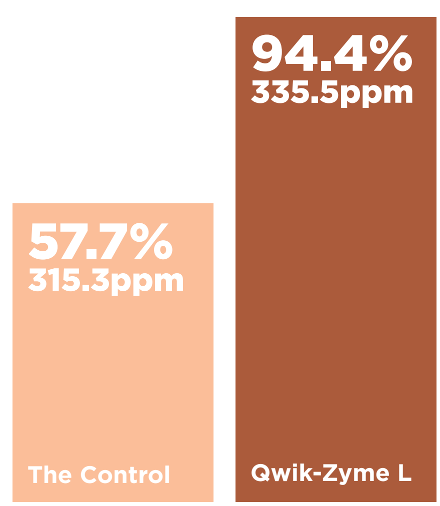
94.4%

VS.

The Control

57.7%

In all the fat sources tested, the addition of the Qwik-Zyme L biocatalyst aided in the removal fatty acids from wastewater.



Abstract

The presence of fats, oils, and greases (FOG) is a major concern for municipal and industrial wastewater treatment plants. The point of entry of these FOG can be from numerous sources such as; industry, restaurants and homeowners. Regardless of the source, once it reaches the treatment facility it can be difficult to remove and can lead to buildups which can cause blockages and ineffective wastewater treatment.

The presence of FOG, especially in colder weather conditions, can cause for less desirable wastewater flora to form such as the filaments *Microthrix parvicella* and *Nocardia*. This is because the 'good' bacteria that are responsible for the treatment of wastewater have a difficult time breaking down fats, oils and grease. Filamentous bacteria can also be responsible for the presence of foam in wastewater treatment processes because of their ability to float on the surface.

The objective of this study was to determine the effectiveness of the Qwik-Zyme L (QZL) biocatalyst, a wastewater additive developed and produced by AquaFix Inc. According to product labeling, the addition of QZL, aids in the removal of fats, oils and greases from wastewater. This study was developed at the Wisconsin Institute for Sustainable Technology (WIST) at the University of Wisconsin – Stevens Point. A total of nine different sources of fats were tested. Seven sourced from non-animal, with two sourced from animal products.

This study tested the removal of fatty acids from spiked wastewater samples over a 24-hour period. Wastewater with the QZL added was compared to wastewater without the addition of the biocatalyst. Analysis of the fatty acid loss after the treatment period indicated that the addition of the QZL biocatalyst was effective in aiding in the removal of fatty acids.

Results

Only trace amounts of short chained fatty acids (SCFA) were observed during the study. Due to no quantifiable levels of SCFA having been detected their results will not be individually listed.

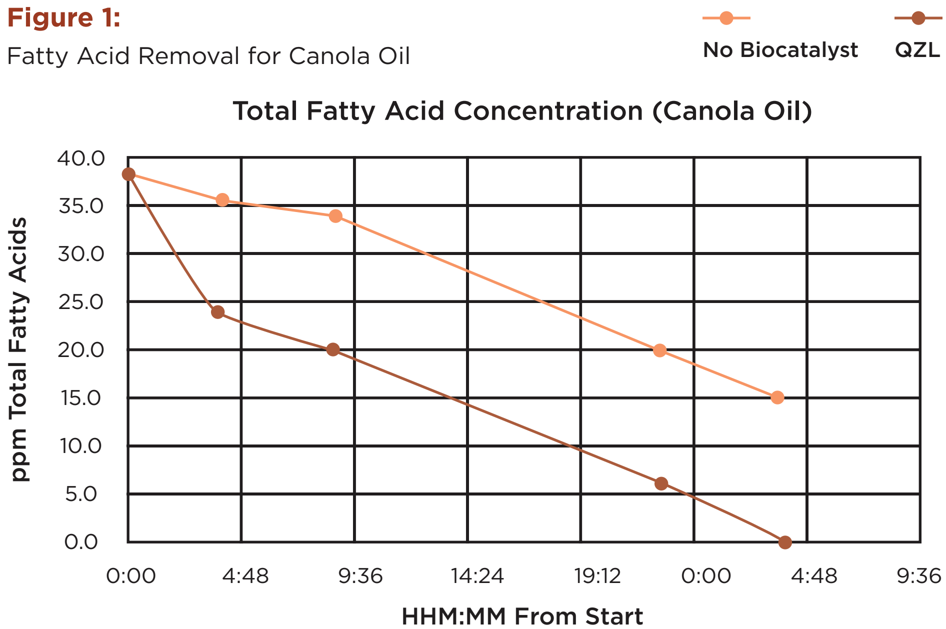
The following graphs illustrate the degradation of the fatty acids present in the wastewater over a 24-hour time period.

Canola Oil

Table 1:
Fatty Acid Removal for Canola Oil as a Percentage

Time	No Biocatalyst	QZL
4:00	4.0%	36.3%
9:00	10.0%	45.7%
22:30	46.4%	81.5%
27:30	60.6%	100.0%

Figure 1:
Fatty Acid Removal for Canola Oil

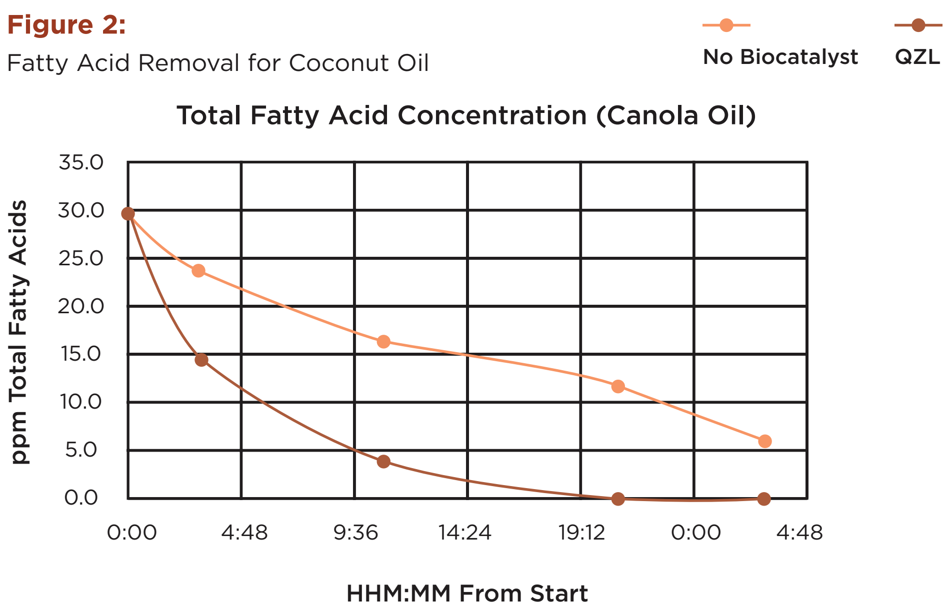


Coconut Oil

Table 2:
Fatty Acid Removal for Coconut Oil as a Percentage

Time	No Biocatalyst	QZL
3:00	21.3%	52.0%
11:00	44.8%	88.2%
21:00	59.5%	100.0%
27:30	79.2%	100.0%

Figure 2:
Fatty Acid Removal for Coconut Oil



Results

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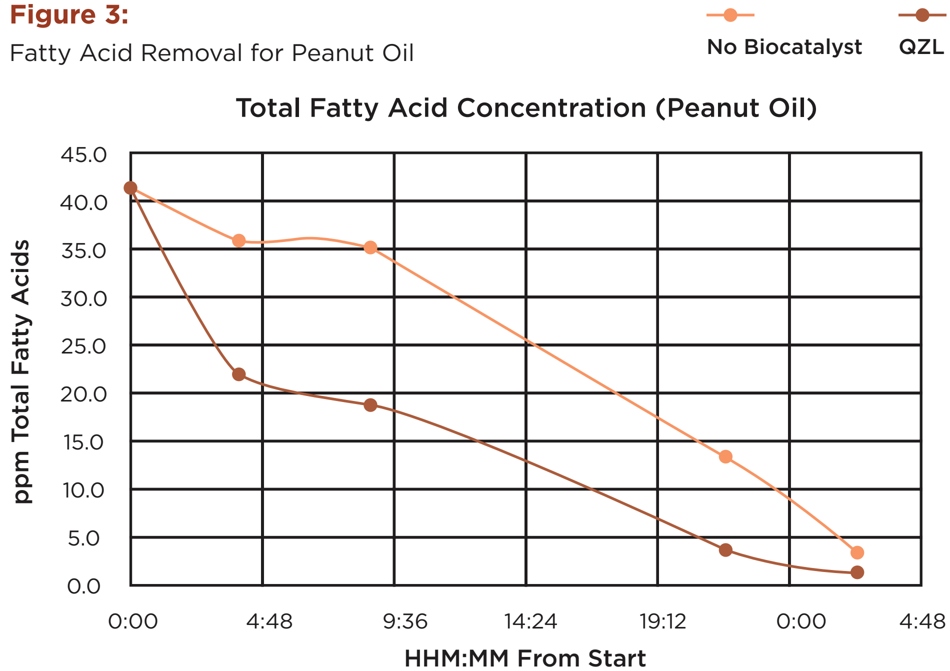
The following graphs illustrate the degradation of the fatty acids present in the wastewater over a 24-hour time period.

Peanut Oil

Table 3:
Fatty Acid Removal for Peanut Oil as a Percentage

Time	No Biocatalyst	QZL
4:00	15.2%	46.6%
9:00	16.2%	55.0%
21:30	69.1%	90.9%
26:30	29.8%	100.0%

Figure 3:
Fatty Acid Removal for Peanut Oil

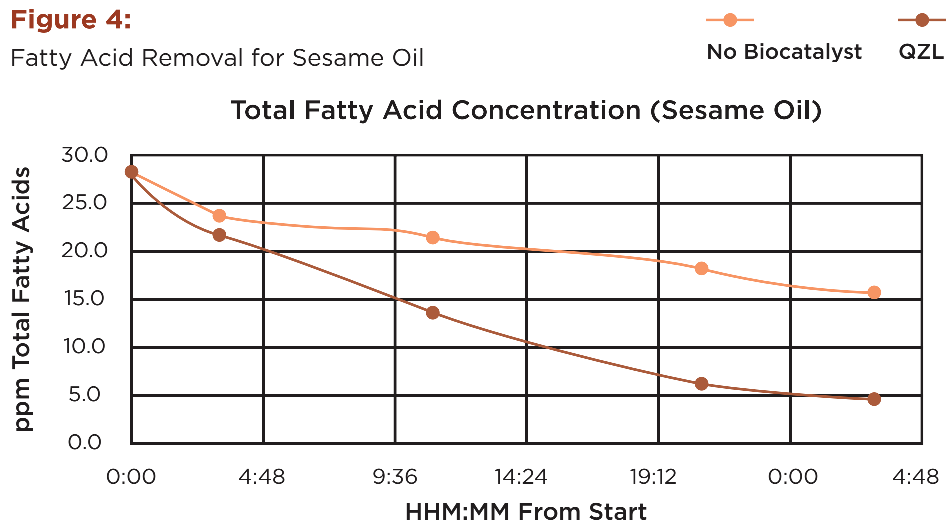


Sesame Oil

Table 4:
Fatty Acid Removal for Sesame Oil as a Percentage

Time	No Biocatalyst	QZL
3:00	13.5%	22.9%
11:00	22.6%	49.9%
21:00	35.2%	77.8%
27:00	44.8%	83.6%

Figure 4:
Fatty Acid Removal for Sesame Oil

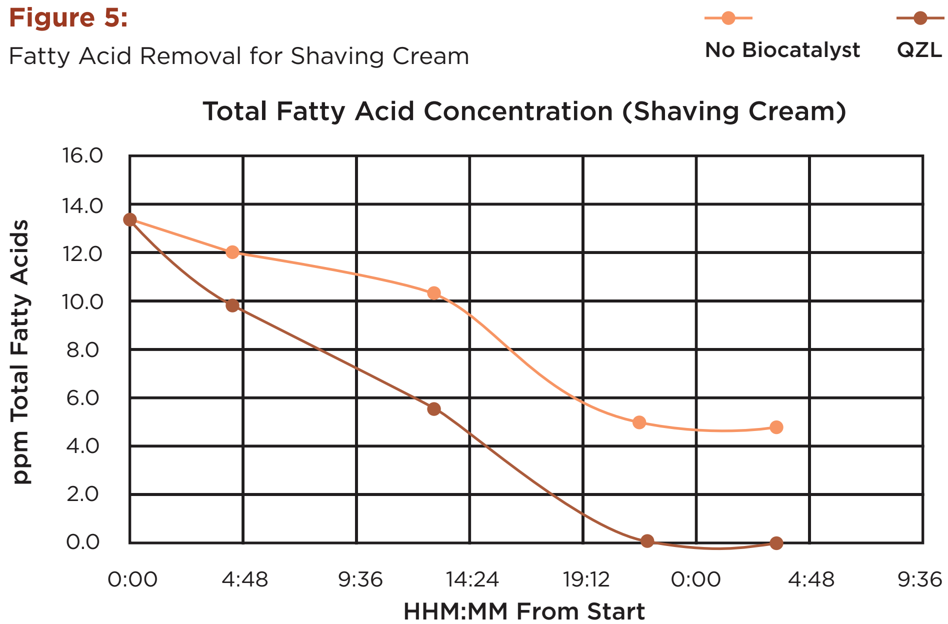


Shaving Cream

Table 5:
Fatty Acid Removal for Shaving Cream as a Percentage

Time	No Biocatalyst	QZL
4:30	9.6%	27.9%
12:00	21.8%	59.5%
22:00	49.0%	100.0%
28:00	50.9%	100.0%

Figure 5:
Fatty Acid Removal for Shaving Cream

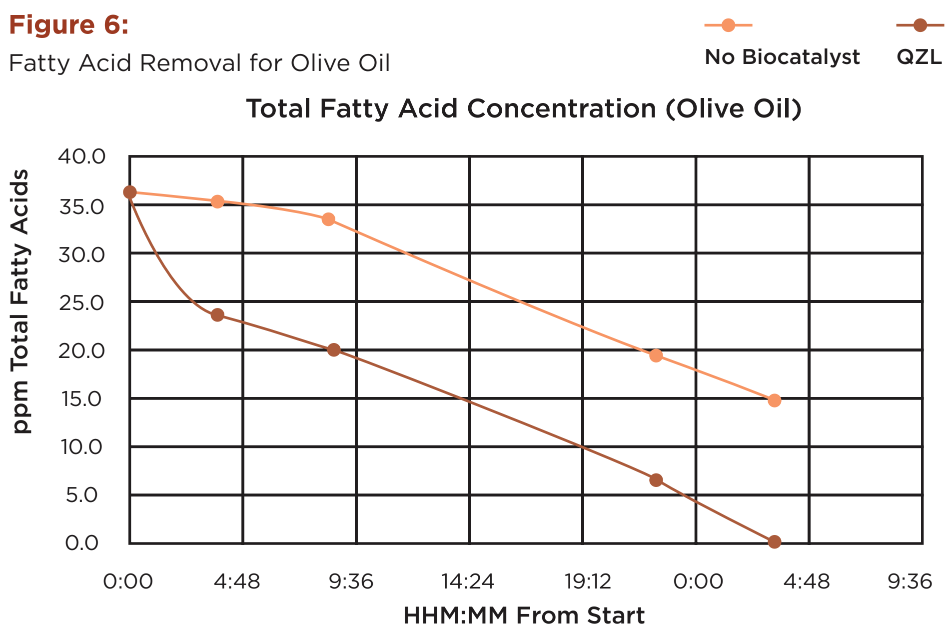


Olive Oil

Table 6:
Fatty Acid Removal for Olive Oil as a Percentage

Time	No Biocatalyst	QZL
4:00	4.0%	36.3%
9:00	10.0%	45.7%
22:30	46.4%	81.5%
27:30	60.6%	100.0%

Figure 6:
Fatty Acid Removal for Olive Oil



Results

Only trace amounts of short chained fatty acids (SCFA) were observed during the study. Due to no quantifiable levels of SCFA having been detected their results will not be individually listed.

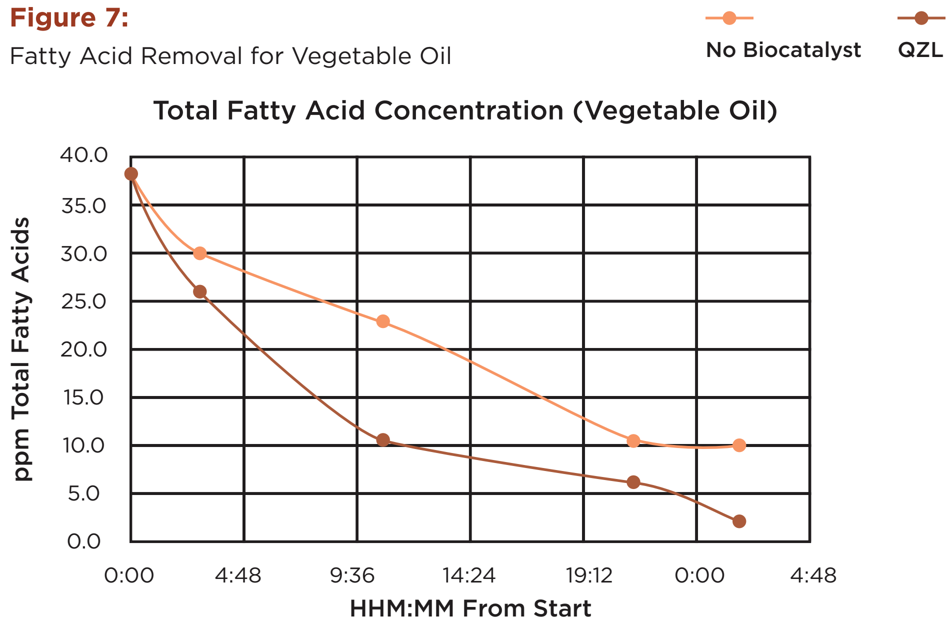
The following graphs illustrate the degradation of the fatty acids present in the wastewater over a 24-hour time period.

Vegetable Oil

Table 7:
Fatty Acid Removal for Vegetable Oil as a Percentage

Time	No Biocatalyst	QZL
2:15	22.1%	31.8%
10:30	40.7%	71.3%
21:30	72.0%	83.9%
26:00	74.2%	92.4%

Figure 7:
Fatty Acid Removal for Vegetable Oil

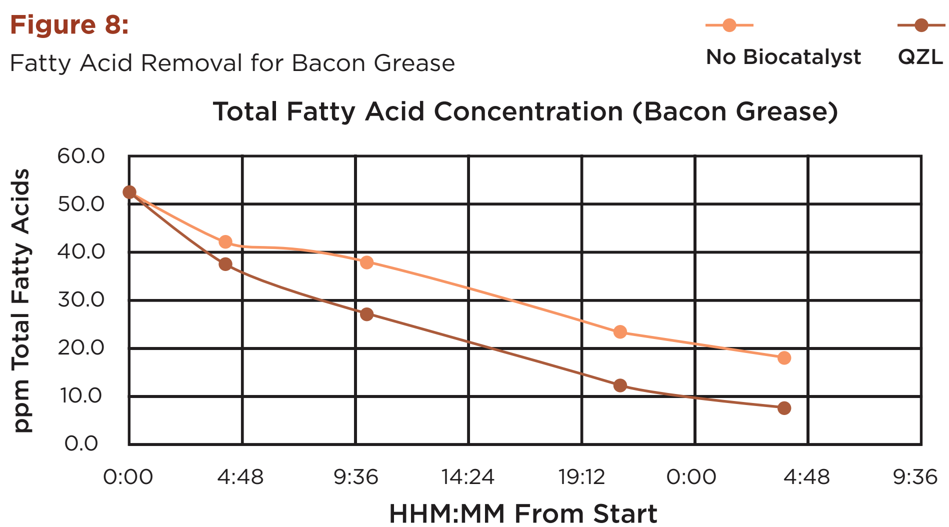


Bacon Grease

Table 8:
Fatty Acid Removal for Bacon Grease as a Percentage

Time	No Biocatalyst	QZL
4:30	13.5%	22.9%
10:00	22.6%	49.9%
21:00	35.2%	77.8%
28:00	44.8%	83.6%

Figure 8:
Fatty Acid Removal for Bacon Grease



Milk Fat

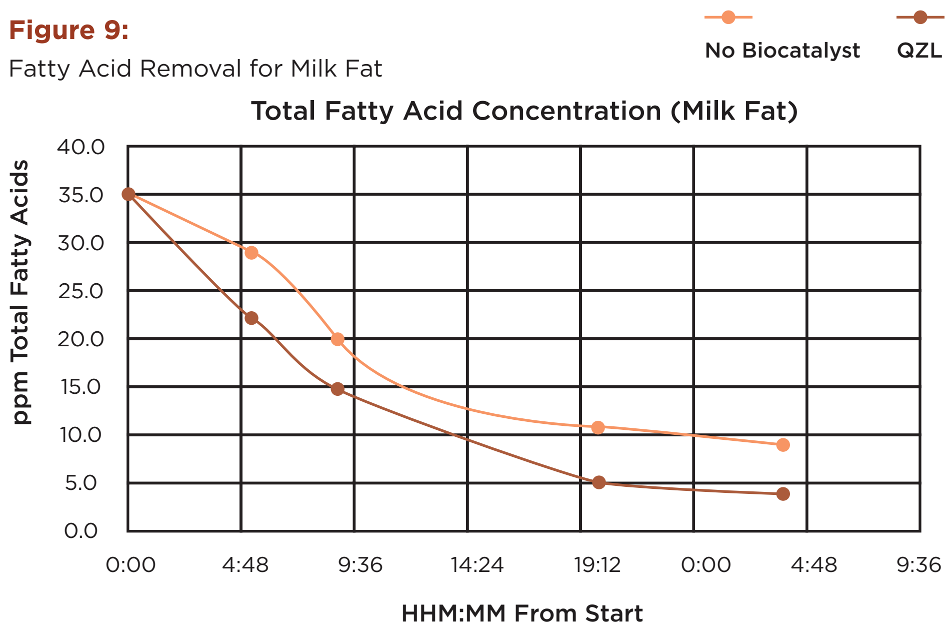
Table 9:

Fatty Acid Removal for Milk Fat as a Percentage

Time	No Biocatalyst	QZL
5:00	17.6%	36.5%
9:00	43.3%	57.8%
20:00	69.2%	85.2%
28:00	74.8%	89.9%

Figure 9:

Fatty Acid Removal for Milk Fat



COD Removal

COD was measured at the start and end of each experiment. Filtered and unfiltered COD samples were analyzed. Listed in Table 10 are the COD results for the initial and the final samples for samples with no QZL biocatalyst and Table 11 for those with the addition of the QZL biocatalyst.

Table 10:
COD Results for Wastewater not Treated with QZL BIOCATALYST

	Initial		Final	
Fat Source	Unfiltered	Filtered	Unfiltered	Filtered
Canola Oil	3841.2	410.0	2693.0	117.4
Coconut Oil	3779.0	415.4	2961.2	104.3
Peanut Oil	4217.0	379.8	1987.6	130.4
Sesame Oil	4219.6	431.9	2741.6	90.4
Shaving Cream	4218.1	391.0	3112.9	117.5
Olive Oil	4913.2	438.7	2917.3	177.9
Vegetable Oil	4693.5	433.1	2840.4	74.2
Bacon Grease	3716.0	427.9	1990.3	100.4
Milkfat	4014.9	414.6	2044.5	91.8

Table 11:
COD Results for Wastewater Treated with QZL BIOCATALYST

	Initial		Final	
Fat Source	Unfiltered	Filtered	Unfiltered	Filtered
Canola Oil	3841.2	410.0	2655.1	121.3
Coconut Oil	3779.0	415.4	2714.0	61.2
Peanut Oil	4217.0	379.8	2111.3	70.6
Sesame Oil	4219.6	431.9	3141.5	70.0
Shaving Cream	4218.1	391.0	2917.4	105.1
Olive Oil	4913.2	438.7	2413.8	77.6
Vegetable Oil	4693.5	433.1	3008.9	71.7
Bacon Grease	3716.0	427.9	2114.9	75.3
Milkfat	4014.9	414.6	1788.3	70.5

Conclusion

In all the fat sources tested, the addition of the QZL biocatalyst aided in the removal fatty acids from wastewater. The biocatalyst appears to aid in the reduction of the fatty acids relatively quickly, increasing the rate of fatty acid removal during the first hours of treatment.

Table 12:
Percent Removal of Fatty Acids at First Sample Draw.

The first samples for fatty acid testing were drawn at about four hours into treatment. Table 12 shows the percent removal at the first sampling for fatty acids.

In each instance the addition of the QZL biocatalyst out preformed the blank wastewater. The average increase in removal of fatty acids at the approximately four-hour mark was 21.2%. The total fatty acid removal was 13.4% in wastewater with no biocatalyst and 34.6% in the wastewater with the QZL biocatalyst added.

Fat Source	Blank	QZL	Difference
Canola Oil	4.0%	36.3%	32.3%
Coconut Oil	21.3%	52.0%	30.7%
Peanut Oil	15.2%	46.5%	31.3%
Sesame Oil	13.5%	22.9%	9.4%
Shaving Cream	9.6%	27.9%	18.3%
Olive Oil	4.0%	36.3%	32.3%
Vegetable Oil	22.1%	31.8%	9.7%
Bacon Grease	13.6%	21.2%	7.6%
Milkfat	17.6%	36.5%	18.9%
Average	13.4%	34.6%	21.2%

Table 13:
Percent Fatty Acids at End of Treatment Period

There was a 27.7% increase in fatty acid removal at the end of the treatment period. 67.0% of the total fatty acids were removed in the wastewater with no biocatalyst, compared to 94.7% with biocatalyst added.

The effectiveness of the QZL biocatalyst continued for the duration of the treatment. At the end of the treatment period (approximately 24-28 hours) the fatty acid concentrations dropped below quantifiable limits in five of the nine fat sources. Table 13 shows the percentages of total fatty acids removed at the end of each treatment.

Fat Source	Blank	QZL	Difference
Canola Oil	60.6%	100.0%	39.4%
Coconut Oil	79.2%	100.0%	20.8%
Peanut Oil	92.8%	100.0%	7.2%
Sesame Oil	44.8%	83.6%	38.8%
Shaving Cream	50.9%	100.0%	49.1%
Olive Oil	60.6%	100.0%	39.4%
Vegetable Oil	74.2%	92.4%	18.2%
Bacon Grease	64.7%	86.3%	21.6%
Milkfat	74.8%	89.9%	15.1%
Average	67.0%	94.7%	21.2%

Appendix A – Experimental Conditions

Wastewater for this study was obtained from the Stevens Point, Wisconsin municipal wastewater treatment facility. Once in the laboratory, the wastewater was 'washed' to remove excess nutrients. Details of this procedure and others can be found in the methods section of this report.

Table 14:

MiniBio Reactors from Applikon Biotechnology were used to control conditions of the wastewater as listed in Table 14.

A 2.5% solution of sodium carbonate, and 0.05M hydrochloric acid were used to control pH.

Aquafix's SmartBOD was added as a carbon source to provide COD. 10,000 mg/L COD solutions were made and added to the wastewater to obtain the target of 400 mg/L COD.

Parameter / Condition	Target
COD (Filtered)	400 mg/L
pH	7.80
DO	3.0 mg/L
Temperature	Not controlled
Stirring Speed	300 RPM
MLSS	2000 mg/L
QZL Dose	10 gal per 100,000 gal

Temperature was monitored during the study but not controlled. The ambient temperature of the laboratory where the experiments were conducted is usually between 19 and 22°C.

The study looked at a total of nine different sources of fats, seven from non-animal sources with the remaining two from animal. These were; olive oil, peanut oil, canola oil, shaving crème, coconut oil, vegetable oil, sesame oil, milkfat and bacon grease.

For each fat source tested the QZL biocatalyst was compared to a blank, or a wastewater sample with no biocatalyst added, with all other conditions remaining the same. Each test was completed in triplicate.

Figure 10:

Applikon MiniBio Reactor
Used in this study was the 1L Applikon MiniBio Bioreactor. It is a sized-down laboratory scale reactor, regularly used for screening studies and microbial/cell culture batch. The Applikon allowed for precise control of multiple experiment variables, including temperature, nutrient content, pH, and oxygen.

Appendix B – Test Methods

The reactors were tested for MLSS, chemical oxygen demand (COD), long-chained fatty acids (LCFA) and short-chained fatty acids (SCFA).

Table 15:
Table 15 Lists the methods used for each analysis.

Test	Method
Short-Chained Fatty Acids (SCFA)	In House
Long-Chained Fatty Acids (LCFA)	In House
Chemical Oxygen Demand (COD)	SM 5220 D
Mixed Liquor Suspended Solids (MLSS)	SM 2540 D

Short-Chained Fatty Acids

Samples for SCFA were filtered through a 0.22 µm membrane filter and analyzed on a DIONEX ICS-3000 chromatography system equipped with an ICE-AS1 column.

Long Chained Fatty Acids

15 mL of wastewater was removed from the reactor vessel. This sample was then washed 3x with 5mL of hexane. Samples were centrifuged between hexane washings. The hexane fractions were collected in a separate tube and the hexane removed.

Once the hexane was removed 2.5 mL of 2.5% sulfuric acid in methanol was added as a derivatizing agent. Samples were placed in an incubated shaker table for 3 hours at 60°C. LCFA were back extracted by adding 1 to 2 mL of Hexane and vortexing.

The LCFA sample in hexane was ran on an Agilent 7890A GC system equipped with an FID detector and a DB-5 column.

MLSS Washing

Prior to using the mixed liquor obtained from the wastewater treatment facility it was ‘washed’ to remove excess nutrients. MLSS was poured into a 2L graduated cylinder and allowed to settle. Once settled the water was decanted and brought back to 2L with deionized water. This was done a total of three times.

Notes

Study crafted and completed by the

Wisconsin Institute for Sustainable Technology

Product provided by

AQUAFIX Inc.

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