

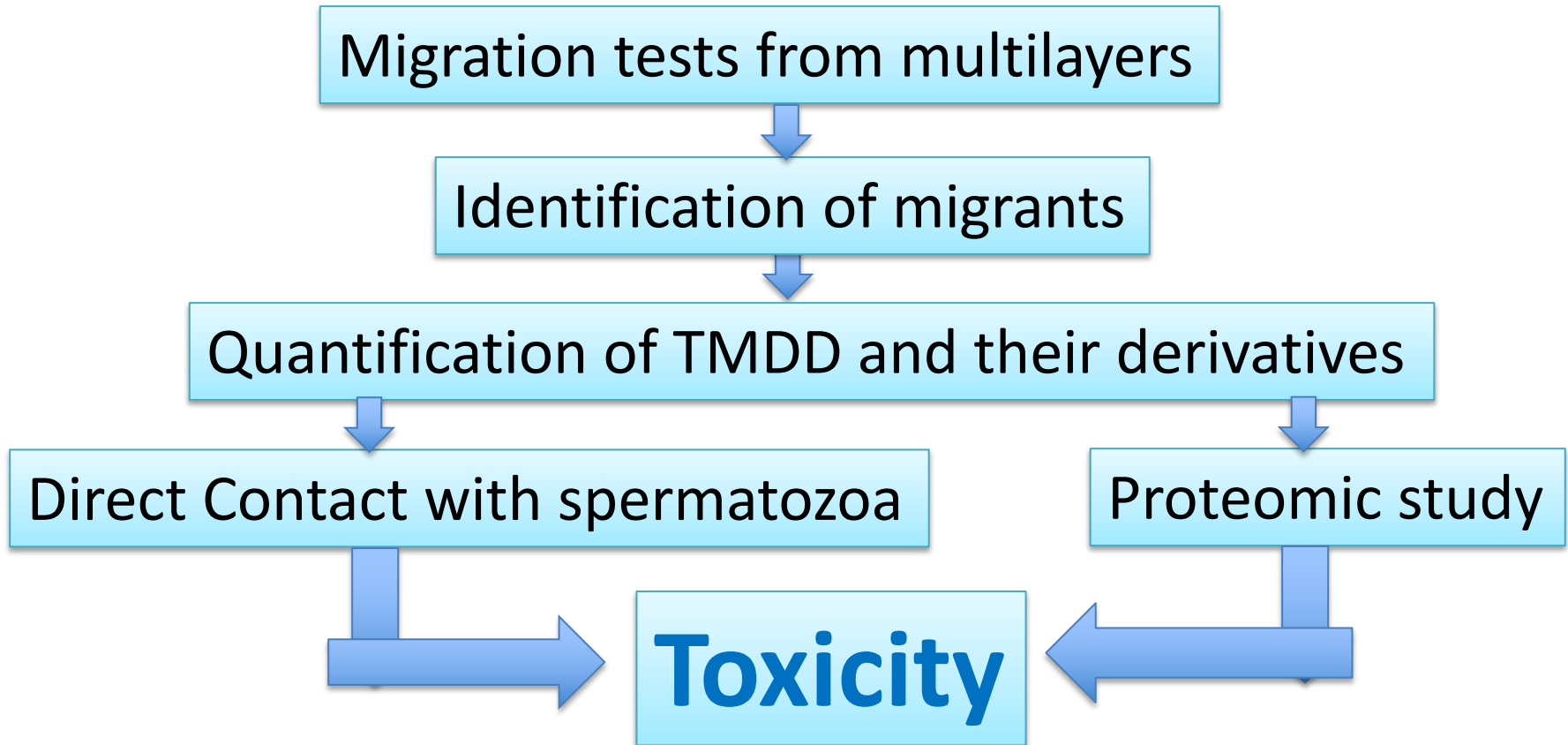
Reprotoxic chemicals in food contact articles: The case of surfynol.

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The origin

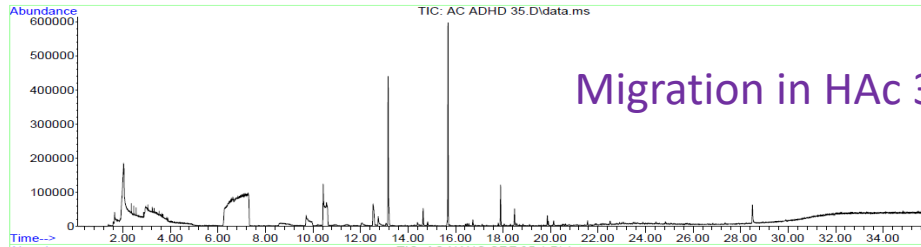
- Multilayers are very common in food packaging
- Adhesives are used to build the laminates (multilayers)
- Most of adhesive formula need surfactants
- Surfactants migrate throughout the plastic and paper layers

The study

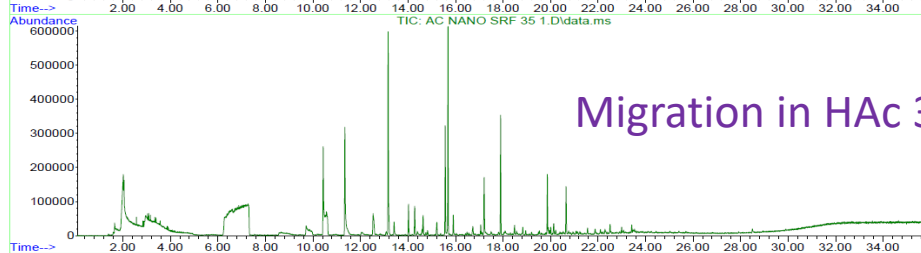


C. Nerin, et al. A common surfactant used in food packaging found to be toxic for reproduction in mammals. *Food and Chemical Toxicology* [Volume 113](#), March 2018, Pages 115-124. <https://doi.org/10.1016/j.fct.2018.01.044>

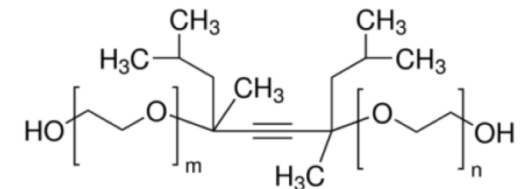
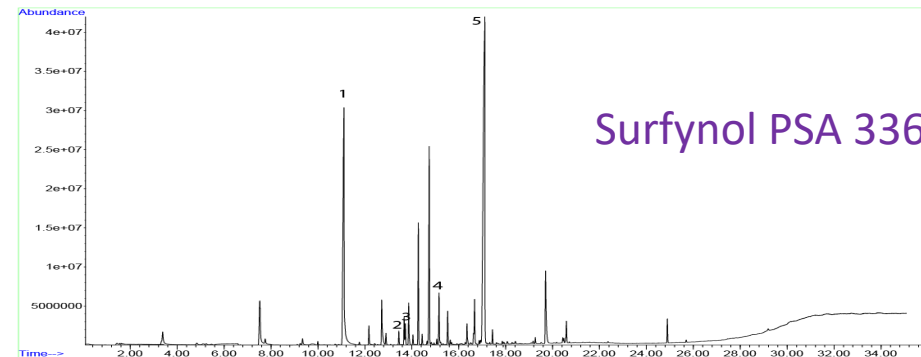
Volatile migrants by HS-SPME-GC-MS



Migration in HAc 3% from Adhesive



Migration in HAc 3% from plastic multilayer



$n=1$ $m=0$

$n=1$ $m=1$

$n=2$ $m=1$

TMDD and derivatives are not degraded in acidic medium (stable for 15 days)

MIGRATION OF NON VOLATILE COMPOUNDS FROM SURFYNOL PSA 336

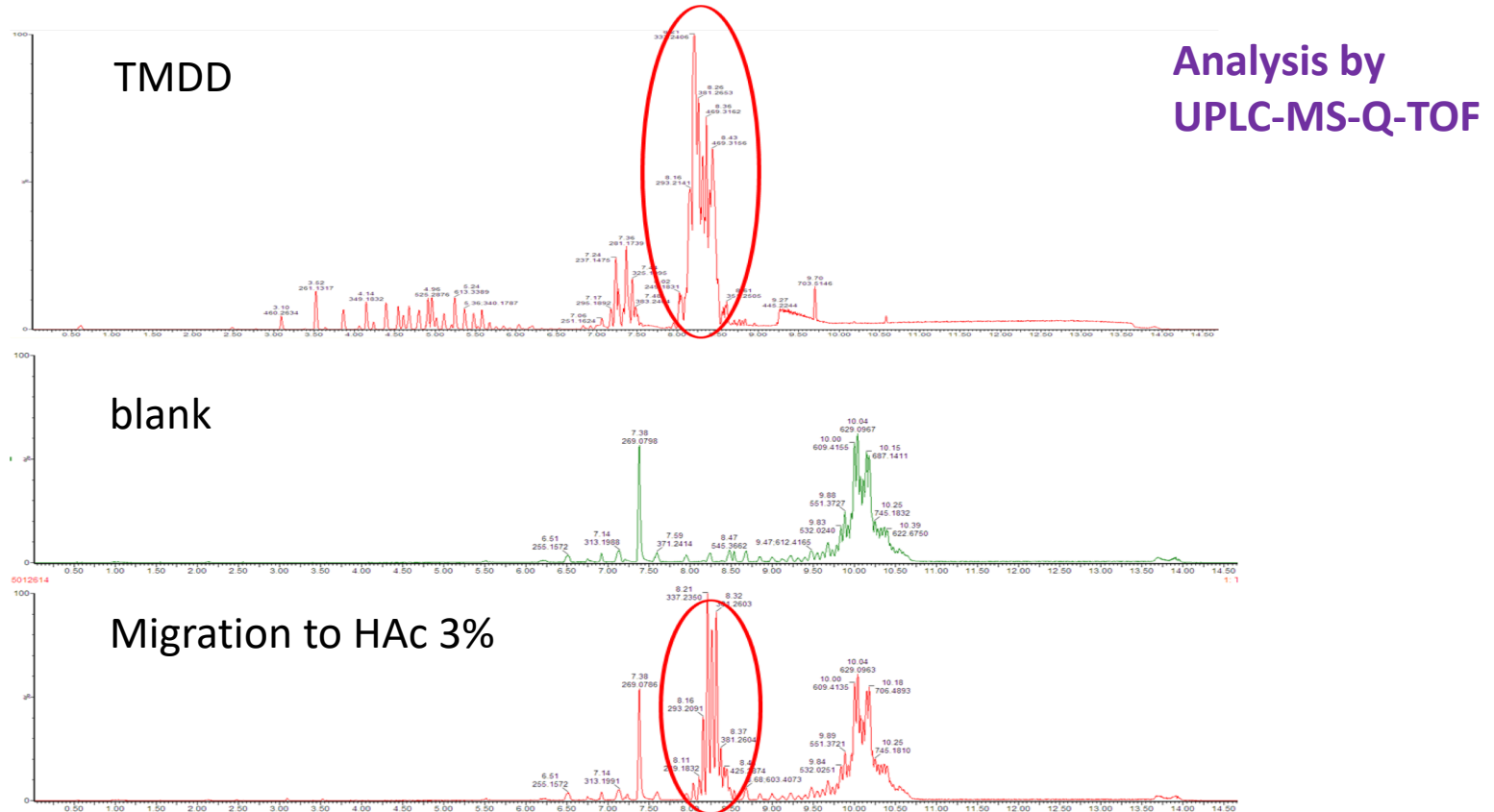
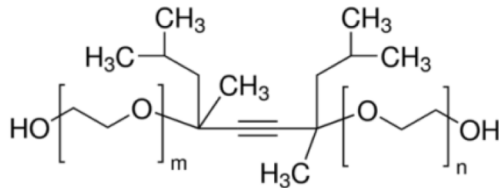


Fig. 1. UPLC-MS-Q-TOF of TMDD (A), blank (B) and acetic acid 3% (C) after exposure to plastic multilayer containing Surfynol.

Surfynol PSA 336: TMDD: 2,4,7,9-Tetramethyl-5-decyne-4,7-diol ethoxylate
Class III Cramer

The migrants found

- TMDD



Present in
Surfynol PSA 336

- Their ethoxilated compounds

n=1 m=0

n=1 m=1

n=2 m=1

Quantitative migration

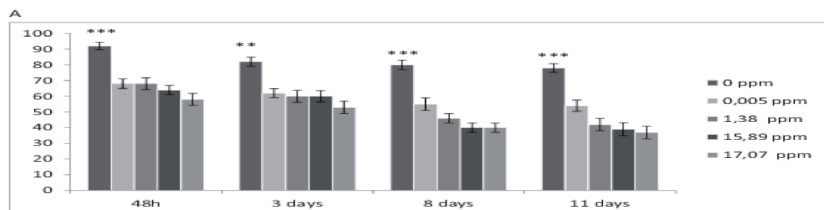
Migration values found after exposure multilayer to both acetic acid 3% and ethanol 10% in water.

Compound/migration mg/Kg	Mass Q-TOF	LOD	Ethanol 10% PE(35 μm)-adh(4 g/m ²)-PET(12 μm)	Ethanol 10% PE(60 μm)-adh(4 g/m ²)-PET(12 μm)	Ethanol 10% PE(90 μm)-adh(3 g/m ²)-PET(12 μm)	AC 3% PE(35 μm)-adh(4 g/m ²)-PET(12 μm)	AC 3% PE(60 μm)-adh(4 g/m ²)-PET(12 μm)	AC 3% PE(90 μm)-adh(3 g/m ²)-PET(12 μm)
1-hexanol-2-ethyl		0.001	0.005	0.003	<LOD	0.011	0.007	0.003
2,4,7,9-Tetramethyl-5-decyne-4,7-diol (sum of isomers)	249.1827	0.012	1.38	0.58	<LOD	0.72	0.33	0.14
2,4,7,9-Tetramethyl-5-decyne-4,7-diol ethoxylate n=1 m=1*(sum of isomers)	337.2353	0.012	17.07	11.08	2.90	13.40	6.42	5.67
2,4,7,9-Tetramethyl-5-decyne-4,7-diol ethoxylate n=2 m=1*(sum of isomers)	381.2614	0.012	15.89	8.81	1.68	12.70	4.77	4.40

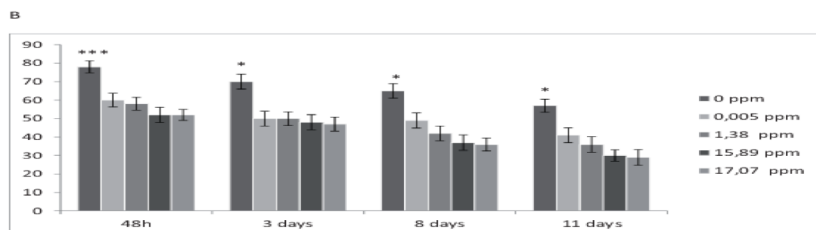
Reprotoxicity by direct contact with spermatozoa

- acrosome integrity,
- mitochondrial activity
- penetration capacity
- motility

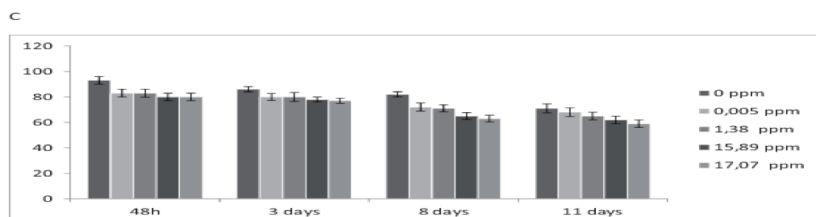
Effect of different amounts of TMDD on functionality markers of boar sperm at 48 hours, 3 days, 8 days and 11 days.



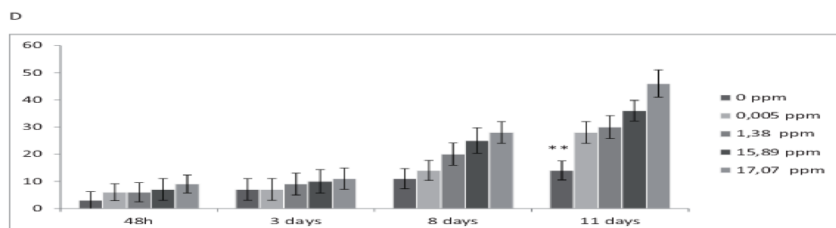
A) Total Motility (n = 10).



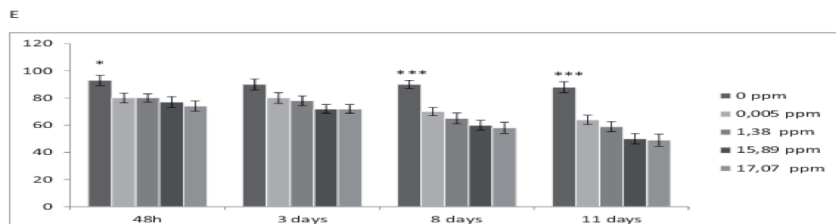
B) Progressive Motility (n = 10).



C) Viability (FITC-PNA-/IP-; n = 10).



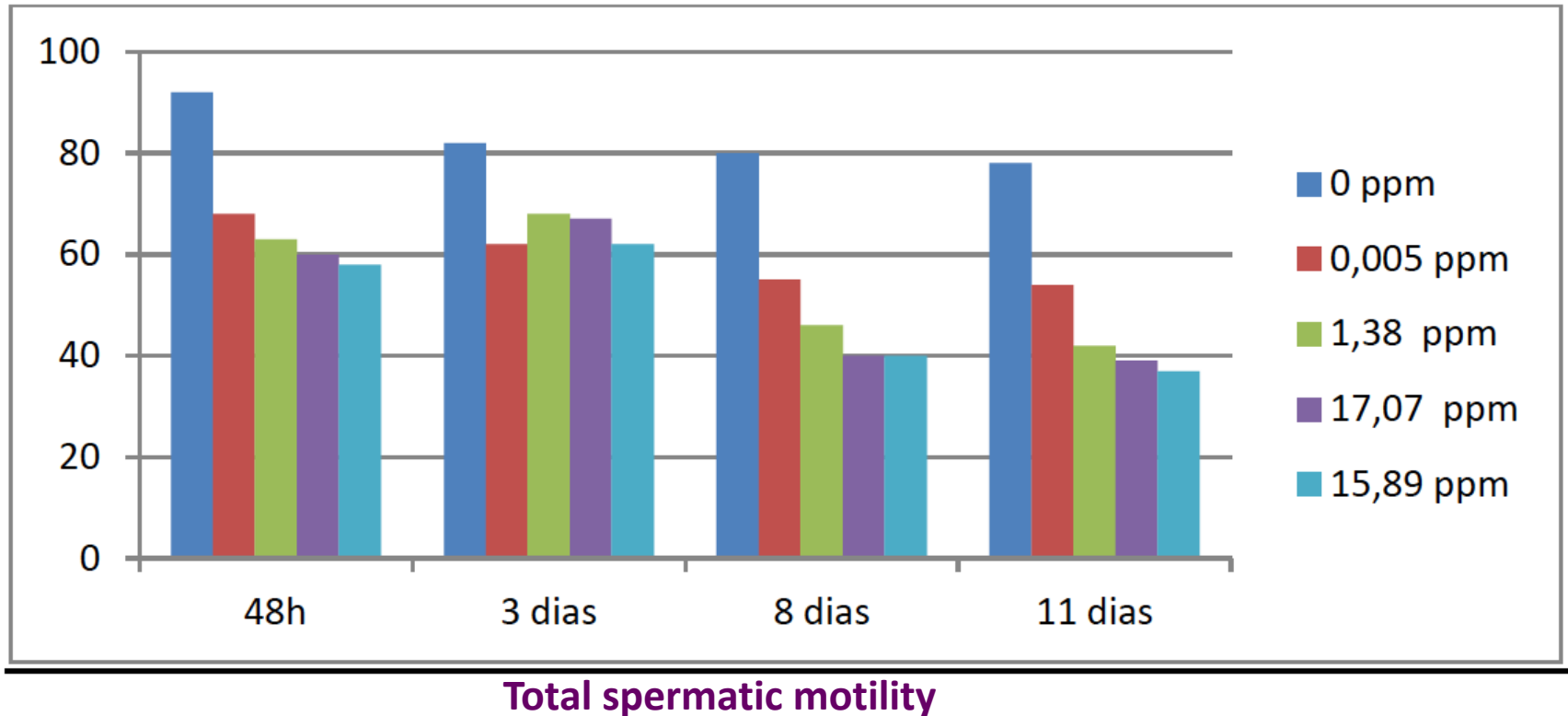
D) Acrosome reacted (FITC-PNA+; n = 10)



E) Mitochondrial Activity (n = 10).

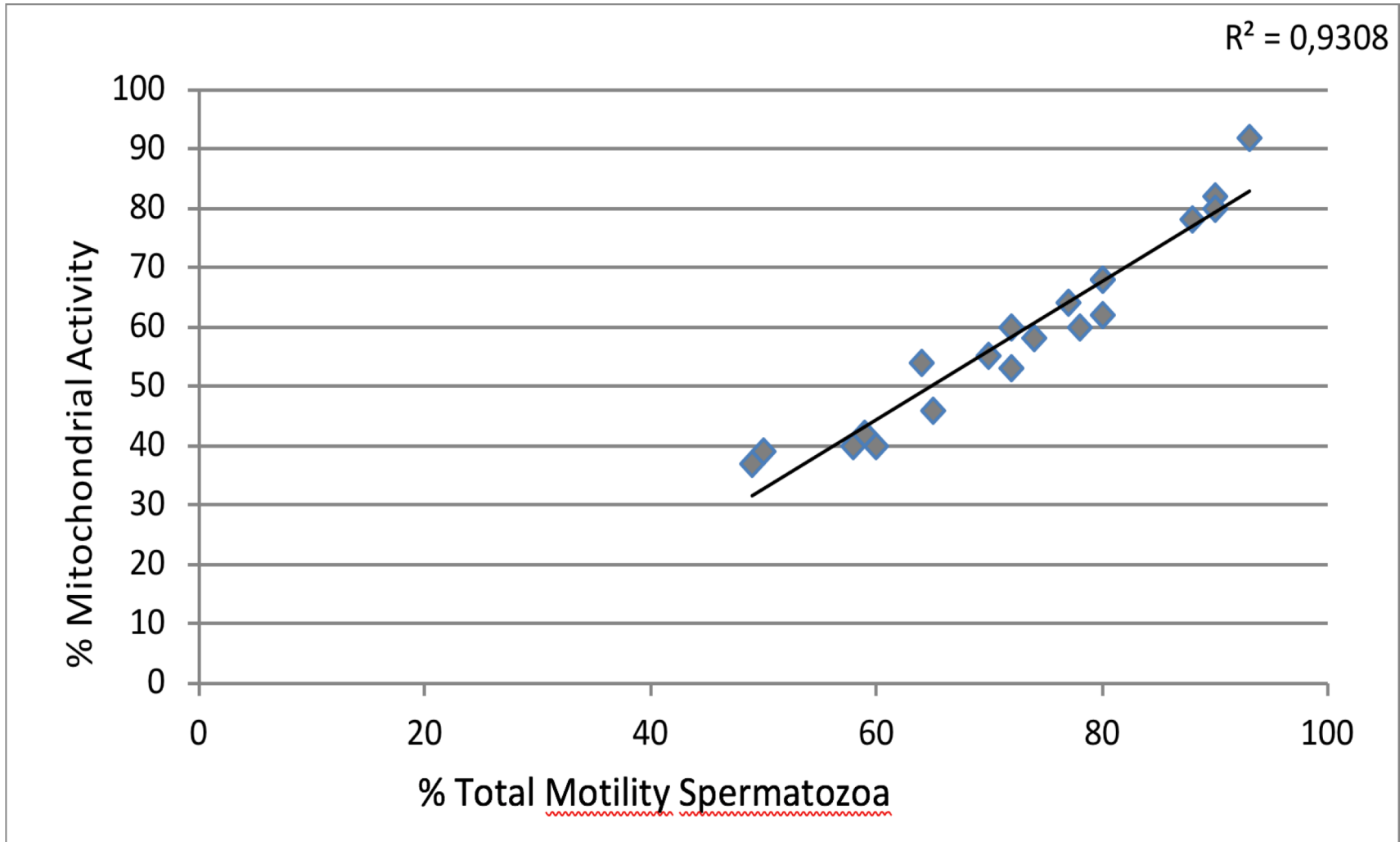
Significant differences related to control:
*P < 0.05, **P < 0.01, ***P < 0.001

Effect of Surfynol on reproduction

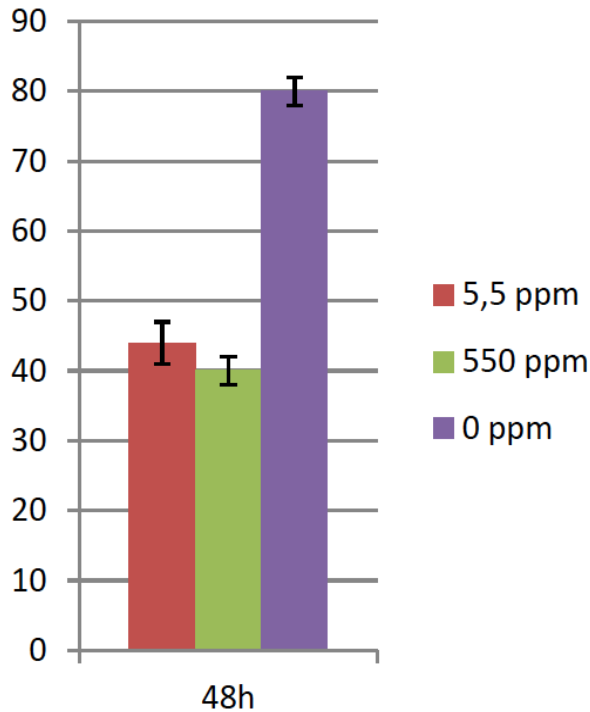


Surfynol PSA 336 surfactant directly affects the fecundity of spermatozoa, and this effect is concentration dependent.

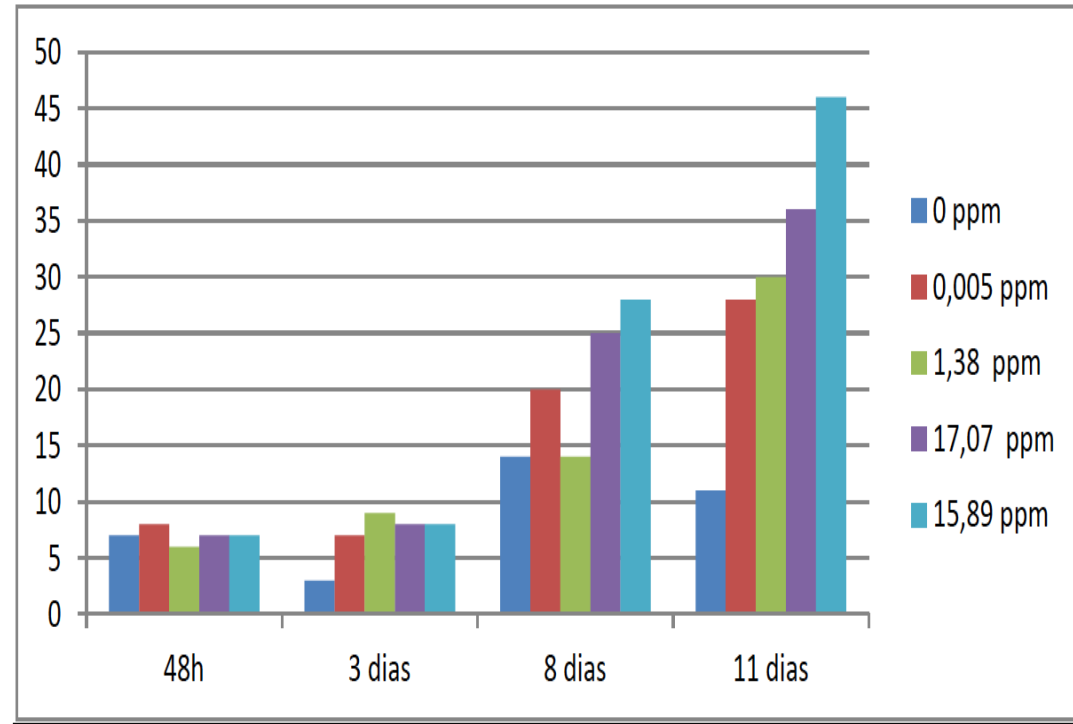
Percentage of spermatozoa with mitochondrial activity versus total motility



Effect of Surfynol on reproduction



Penetration
test

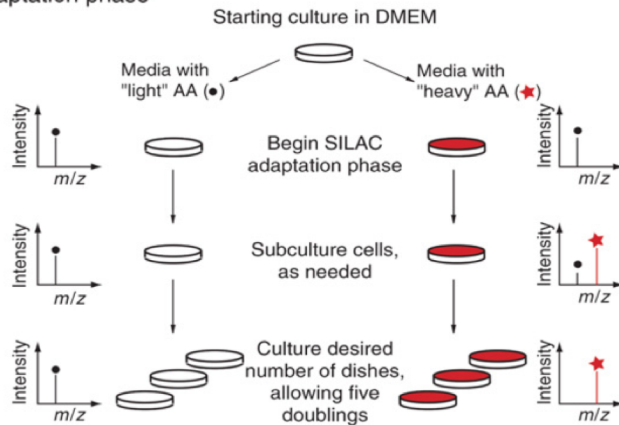


Reacted acrosome (FITC-
PNA+)%

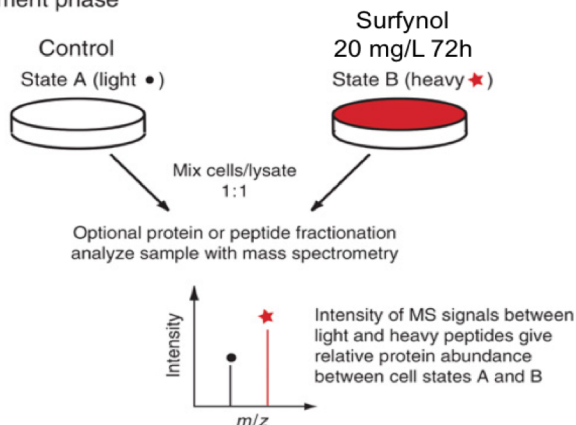
PROTEOMIC STUDY

SILAC

a Adaptation phase



b Experiment phase



Germinal cells of testicular embryonal carcinoma
(NTERA 2 MODEL)



Decrease in cell viability from 85% to 5% was observed with increasing concentrations of surfynol from 1mg/L to 50 mg/L respectively



50 mg/L) caused the cellular death of almost the entire cell culture

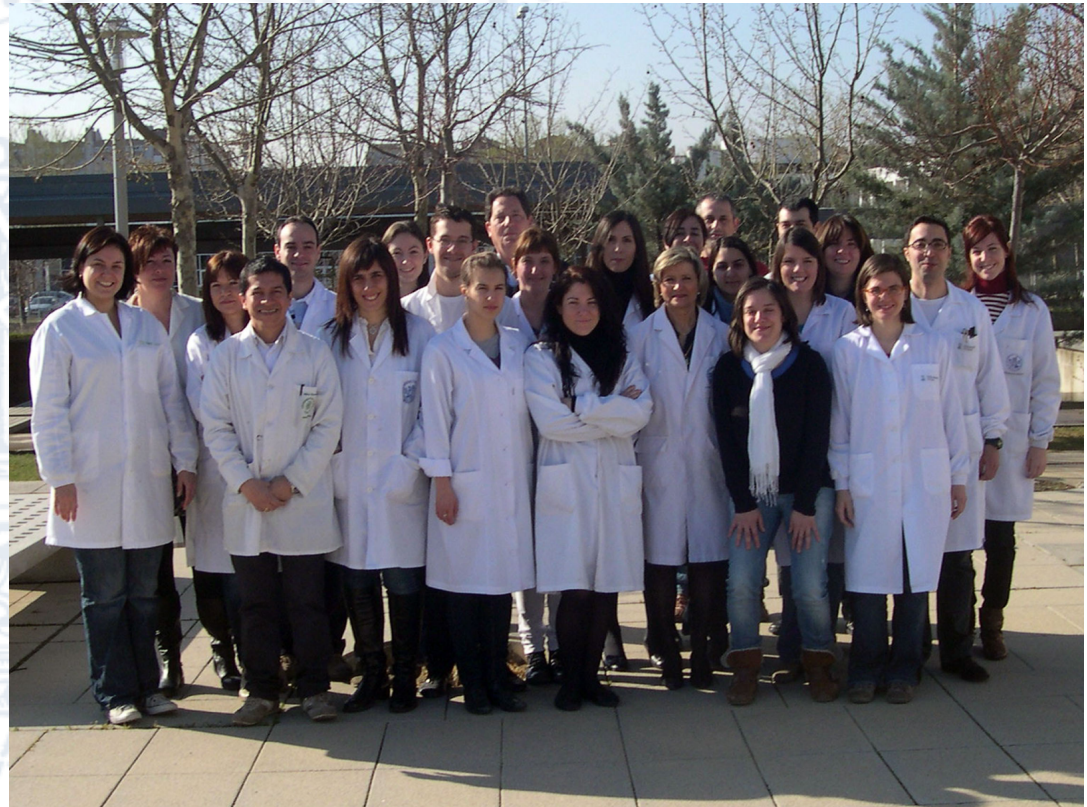
Conclusions

- Reprotoxicity (male infertility) has been demonstrated by *direct contact between the migrants and the spermatozoa*.
- Reprotoxicity effect was confirmed by the proteomic analysis.
- Added substances (IAS, surfactant) were the cause of reprotoxicity in this case
- TMDD and their ethoxylated compounds as surfactants are quite common in food packaging materials
- Identification and quantification of migrants is extremely important!

Acknowledgements

Research Projects:

- SAFEMTECH (IAPP-Marie Curie)
- SAENMA (AGL-2012, National)
- **MAGAPOR**
- MIGREFILMS
- MIGRESIVES (EU)
- Nafispack (EU project)
- Naturalpack (EU project)
- **Nanoflexipack** (National)
- FOODYPLAST (EU Project)
- R&D&i with several companies
-



GUIA GROUP, UNIVERSITY OF ZARAGOZA, SPAIN

**Thank you very much
for your attention!**

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