Technical Difficulties of Reducing Saturated Fat in Filled Chocolate Confectionery

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Outline

- Chocolate
  - Composition of fat phase
  - Constraints on chocolate composition
  - Options for saturates reduction
- Fillings
  - Composition of fat phase
  - Effects of changing filling fat on:
    - Migration and chocolate softening
    - Saturates reduction

Saturated fat intake from chocolate confectionery (% energy)

	Men	Women
Total	35.8	34.9
Saturated	**13.4**	**13.2**
Trans	1.2	1.2
Cis-MUFA	12.1	11.5
Cis-n-3-PUFA	1.0	1.0
Cis-n-6-PUFA	5.4	5.3

Source: NDNS 2002

Contribution from chocolate confectionery:

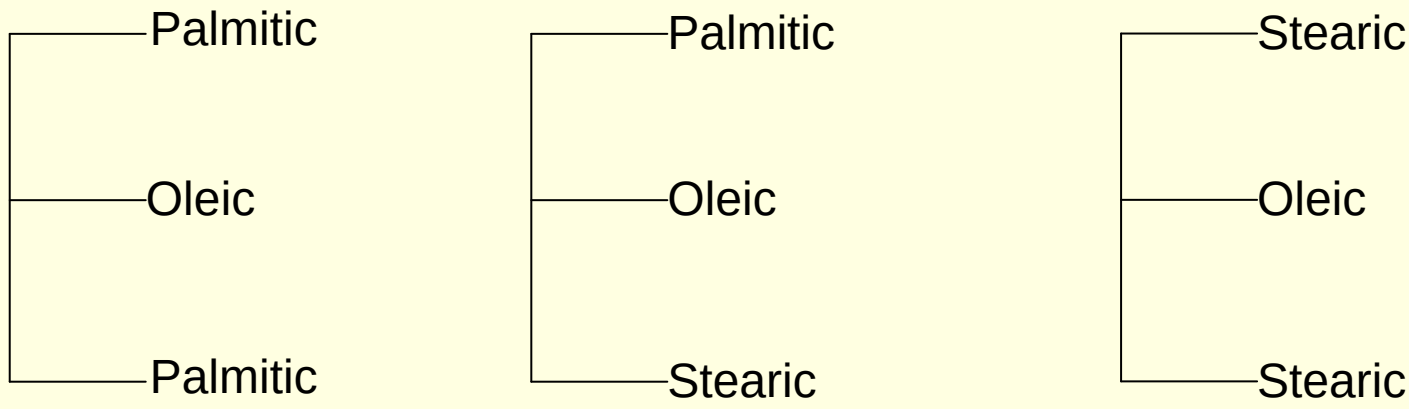
Total: 1.0%
Sats: 0.6%

About 5% of dietary saturates is from chocolate confectionery

Chocolate
Composition of the fat phase

- For simplicity only chocolate that is permissible within the current EU Chocolate Regulations will be discussed
- This can contain up to three different fats:
  - Cocoa butter
  - Milk fat
  - Vegetable fat

Cocoa butter – triglyceride structure



POP	**POSt**	**StOSt**
16%	**40%**	**27%**

Triglyceride contents are for a typical West African cocoa butter

Cocoa butter – fatty acid composition

C14:0	0.1
C16:0	26.0
C16:1	0.3
C18:0	34.4
C18:1	34.8
C18:2	3.0
C18:3	0.2
C20:0	1.0
C22:0	0.2

This is a typical composition for a West African cocoa butter

Total saturates: 61.7%

Milk fat – composition (main acids)

C4:0	3.5	C16:0	25.0
C6:0	2.2	C16:1	2.6
C8:0	1.2	C18:0	12.1
C10:0	2.8	C18:1	27.1
C12:0	2.8	C18:1 (br)	1.3
C14:0	10.1	C18:2	2.4
C14:1	1.6	C18:3/ C20:0	2.1
C15:0	1.1		

Total saturates varies with season and animal feed.

Typically 63% but can range from 55% to 75%

Vegetable fats

- Blends of palm fractions, shea fractions, illipe etc
- Composition is intended to mimic that of cocoa butter and so in a conventional cocoa butter equivalent the saturates level is about 64%
- All three fats contain, typically, 60-65% saturates

Chocolate compositions (total fat 30%)

Component	Dark	Milk	Milk + CBE
Cocoa mass	40.0	15.0	15.0
Cocoa butter	8.0	16.75	11.75
Sugar	51.6	47.85	47.85
SMP		15.0	15.0
Milk fat		5.0	5.0
CBE			5.0
Lecithin	0.4	0.4	0.4
Saturates from CB	61.7	51.4	41.1
Saturates from MF		10.5	10.5
Saturates from CBE			10.7
Total sats (fat phase)	**61.7**	**61.9**	**62.3**
Total sats (chocolate)	**18.5**	**18.6**	**18.7**

What can be done within the scope of the EU Chocolate Directive?

- Reduce total fat
- Use a different type of cocoa butter
- Use a cocoa butter fraction (oleine)
- Use a more unsaturated vegetable fat

- There is no possibility to use milk fat oleine as the regulations state that milk components must be present in the ratios found in whole milk

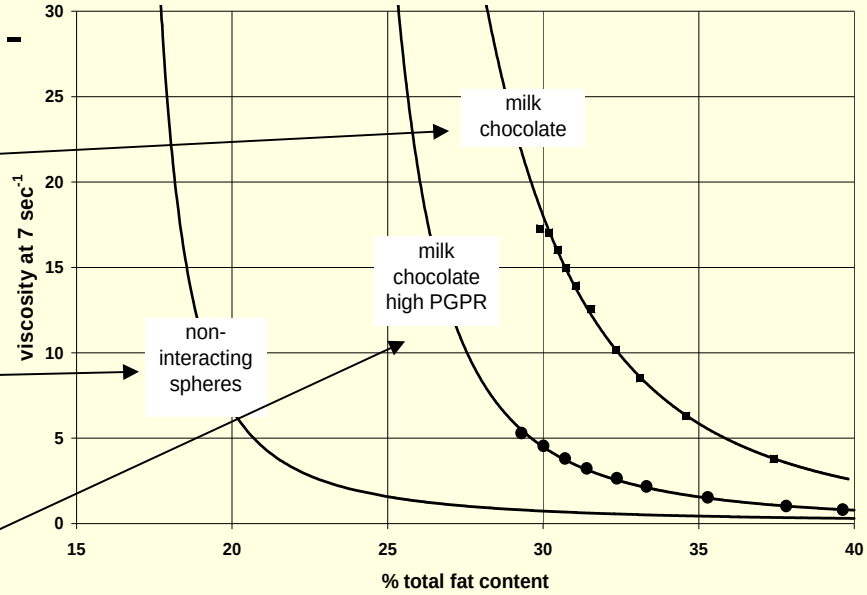
Reduce total fat

- Minimum fat content permitted in chocolate is 25%
- At least 25% of chocolate must be cocoa butter and/or milk fat - so
- CBE would no longer be permitted at that level

	Dark	Milk
Cocoa mass	40.0	15.0
Cocoa butter	3.0	11.75
Sugar	56.6	52.85
SMP		15.0
Milk fat		5.0
Lecithin	0.4	0.4
Total fat	25.0	25.0
Sats (CB)	61.7	49.4
Sats (MF)		12.6
Total sats (fat)	61.7	62.0
Total sats (chocolate)	**15.4**	**15.5**

Reduce total fat

- Reductions in total saturates in the chocolate from about 18.5% down to about 15.5% achievable
- This is a reduction of 16% - but -
- The viscosity of the chocolate will rise considerably
- Refining and particle size reduction will need to change to give a highly tailored mix of particle sizes
- Extra or different emulsifier cocktail may also be needed



Wells MA – from "Science and technology of enrobed and filled chocolate, confectionery and bakery products" ed Talbot G, to be published 2009

Use a different type of cocoa butter

- West African cocoa butter contains typical saturates levels of about 62%
- Brazilian cocoa butter contains typical saturates levels of about 56%
- A direct replacement of West African CB by Brazilian CB in the standard recipes would reduce saturates from 18.5-18.7% of the chocolate to 16.8-17.6% of the chocolate – a reduction of 6-9%

Use a cocoa butter oleine

- Cocoa butter oleine typically contains about 59%
- A direct replacement of West African CB by cocoa butter oleine in the standard recipes would reduce saturates from 18.5-18.7% of the chocolate to 17.4-17.9% of the chocolate – a reduction of 4-6%
- Cocoa butter oleine will, however, be more expensive than cocoa butter and there will be the issue of what to do with the stearine which will contain about 66% saturates

Use a more unsaturated vegetable fat

- The EU Chocolate Directive permits the use of six fats as well as fractionation as a modification process
- Although the mid-fraction from palm oil usually forms the basis of many CBEs, the regulations would, in theory, permit the use of palm oleine (although perhaps the points of compatibility and miscibility across the board with cocoa butter may be moot).
- Palm oleine contains about 43% saturates

Use a more unsaturated vegetable fat

- If palm oleine were used in the CBE recipe as the vegetable fat then the saturates would reduce from 18.7% of the chocolate to 17.7% (a reduction of 5%)
- If this were combined with the use of Brazilian cocoa butter as well then the saturates would reduce to 16.5% of the chocolate (a reduction of 12%)

So why don’t we do these things?

- Because all of these changes in the composition of the fat phase soften the chocolate.
- The only way to compensate for this is to reduce the milk fat.

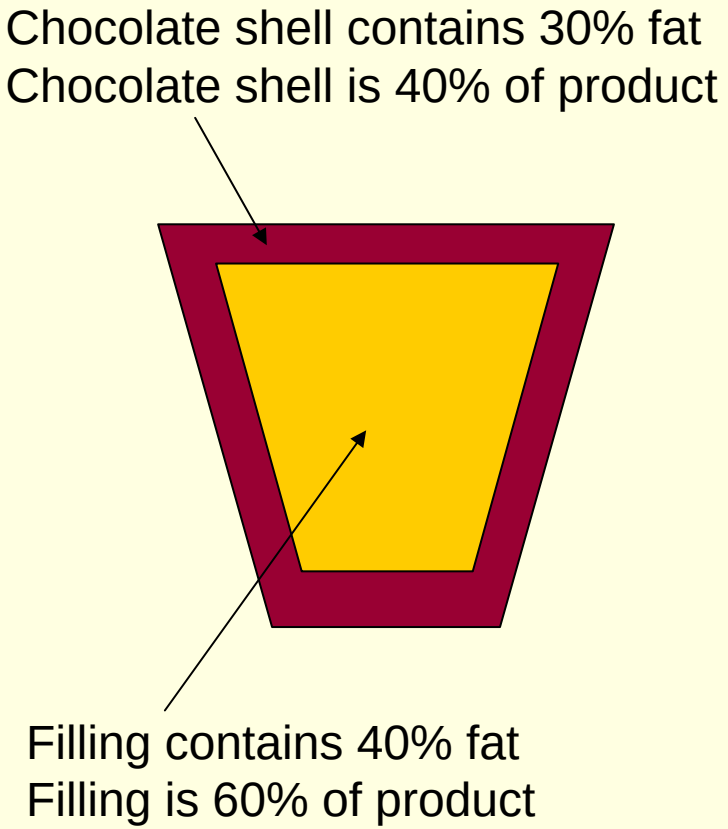
Low milk-fat compositions

Composition	N20	N25	N30	Sats (Fat)	Sats (Choc)
WACB + 16.7% MF	63.5	53.1	23.2	61.9	18.6
BZCB + 3% MF	62.6	53.3	25.1	56.2	16.7
				% Reduction	**10**
WACB + 16.7% MF	63.5	53.1	23.2	61.9	18.6
WACB + 45% CBOl	63.6	53.0	20.0	60.6	18.2
				% Reduction	**2**
WACB/CBE + 16.7% MF	63.8	52.3	20.7	62.3	18.7
WACB/POOl + 2% MF	62.2	52.5	23.3	58.8	17.6
				% Reduction	**6**

Is it any easier to change the composition of the filling?

Composition of filled confectionery

- Filled chocolate shells generally contain more filling than chocolate
- The filling generally has a higher total fat content
- Only general assumptions can be made in defining compositions
- The ones made here are:



Filling composition

- Fillings are not defined by law in the same way as chocolate is
- Fats used in fillings can range from 100% liquid oils (such as hazelnut oil) through to hard fats (such as cocoa butter)
- The more liquid the fat phase of the filling the less saturated it is
- The more liquid the fat phase of the filling the more it will migrate into the coating
- This causes softening and fat bloom to form

Typical filling fats

Filling Fat	% Saturates
Palm kernel oil	82
Fractionated palm oil	54
Hazelnut oil	7
60/40 Hazelnut oil/Cocoa butter	29
80/20 Hazelnut oil/Cocoa butter	18

Total compositions of filled chocolates

Filling fat	Saturates from chocolate	Saturates from filling	Total saturates
Palm kernel oil	7.4	19.7	27.1
Fractionated palm oil	7.4	13.0	20.4
Hazelnut oil	7.4	1.7	9.1
60/40 HZ/CB	7.4	7.0	14.4
80/20 HZ/CB	7.4	4.3	11.7

Comparison of lauric and non-lauric filling fats (4 weeks at 25ºC)

	Degree of migration	Soft-ness of choc-olate	N20	N25	N30	Total Sats
Control	0	~4	76.0	70.7	51.8	
Palm kernel oil	39.9	65.8	36.1	18.3	8.8	27.1
Fractionated palm oil	33.2	20.8	56.1	47.7	24.7	20.4

Using fractionated palm oil as a filling gives an overall reduction in saturates of 25% - and a better product

Effect of adding hard fat to hazelnut oil filling in plain chocolate shells
Solid fat contents of chocolate after storage

Filling	4 weeks at 25ºC			8 weeks at 25ºC		
	N20	N25	N30	N20	N25	N30
Plain chocolate	79.1	71.2	42.1	79.1	71.2	42.1
Hazelnut oil	37.5	25.9	9.1	25.8	16.5	0.0
60/40 HZ/CB	72.2	59.6	32.2	60.2	52.4	20.4

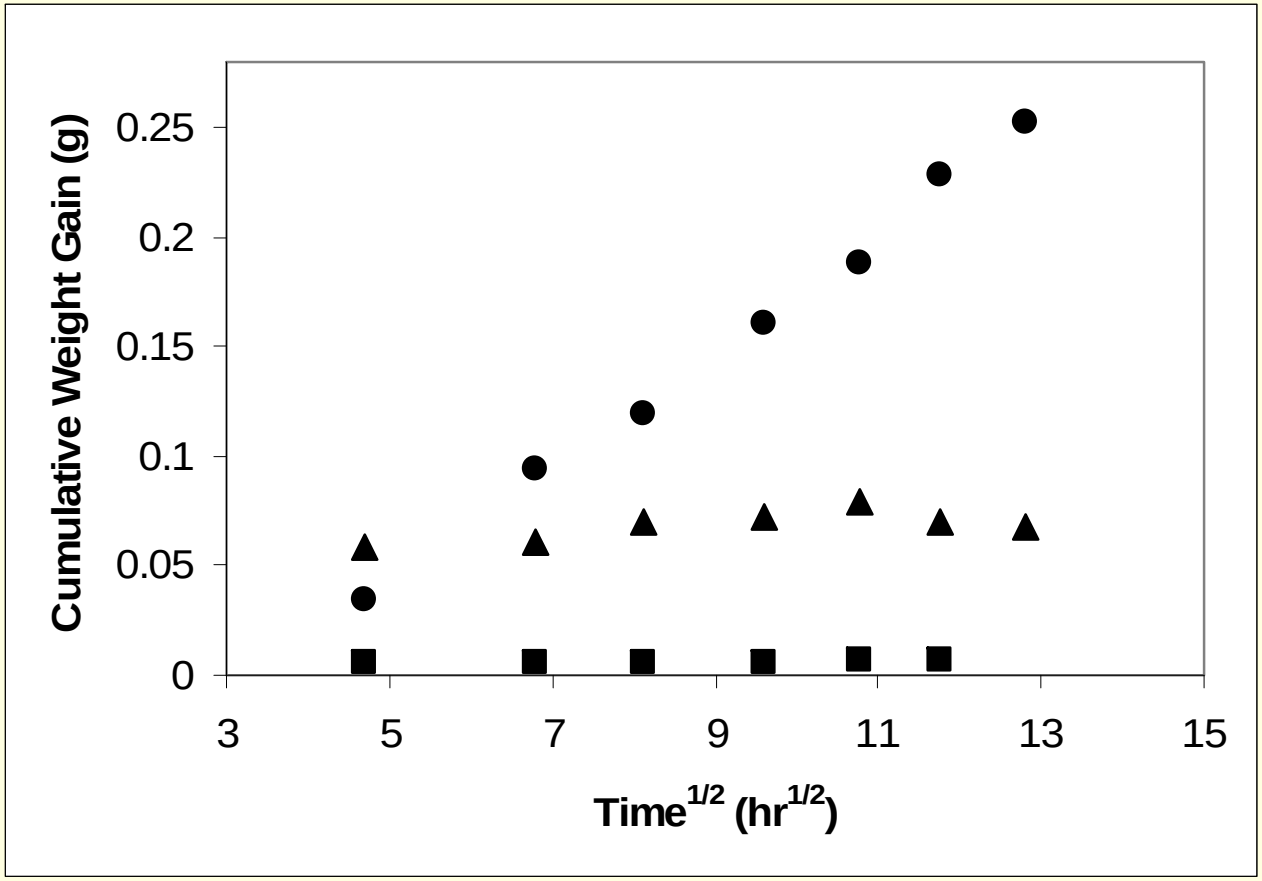
60/40 HZ/CB gives a reduction in saturates of 47% compared with palm kernel oil, and of 29% compared with a fractionated palm oil

Saturation of hazelnut oil with cocoa butter

- Ziegler and Szlachetka (2005) found that if squares of chocolate are laid on filter paper saturated with hazelnut oil, significant migration of oil into the chocolate occurs.
- If the hazelnut oil is saturated with cocoa butter (20% cocoa butter) migration is significantly reduced
- Saturates are also significantly reduced

Ziegler, G.R. & Szlachetka, K. 2005. Where is the nut oil in chocolate? New Food, 8(3), 45-52

Saturation of hazelnut oil with cocoa butter



Circles: hazelnut oil

Squares: cocoa butter

Triangles:

80% hazelnut oil + 20% cocoa butter

Ziegler G – from “Science and technology of enrobed and filled chocolate, confectionery and bakery products” ed Talbot G, to be published 2009

Palmitic-rich or stearic-rich?

- Increasing the chain length of the saturates in a filling can give the same physical properties at a lower level of saturates.
- For example:
  - Assume a filling fat needs to melt at 27ºC
  - Assume also it is made from palm fractions (predominantly composed of POP and POO)
  - Melting point of POP is 36ºC
  - Melting point of POO is 18ºC
  - Assuming no eutectic effects between the two a 1:1 blend will have a melting point of 27ºC
  - It will also contain 50% saturates

Palmitic-rich or stearic-rich?

- Now assume instead of basing it on palm oil it is based on, say, shea oil (rich in StOSt and StOO)
- Melting point of StOSt is 43ºC
- Melting point of StOO is 23ºC
- To get a melting point of 27ºC the blend needed is:
  - 80% StOO + 20% StOSt
- This contains 40% saturates (a reduction of 20%)
- …and the saturates are mainly stearic acid!!

So what exactly can be achieved in chocolate?

- Assume a standard chocolate contains 18.5-18.7% saturates
- Reducing fat content from 30% to 25% will give a 16% reduction in saturates – but the chocolate will be more difficult to use because of its higher viscosity
- Moving from West African to Brazilian cocoa butter will reduce saturates by 6-9%
- Moving from West African cocoa butter to cocoa butter oleine will reduce saturates by 4-6% - at a cost!
- Moving from a conventional CBE to palm oleine as the vegetable fat will reduce saturates by 5%

So what exactly can be achieved in chocolate?

- But – changing the types of fats used like this will also soften the chocolate
- To compensate, milk fat levels will need to be reduced from about 16-17% of the fat phase to max 3%
- Saturates reductions of up to 10% could then be achieved but with a substantially different chocolate

So what exactly can be achieved in fillings?

- Much greater scope here depending on the texture of the filling desired
- Moving from a palm kernel oil filling to one based on palm fractions will reduce saturates by 25% in the filled chocolate – and give a better product
- Another 9% reduction overall might also be achievable by using a stearic-rich filling in place of a palmitic-rich filling
- Moving further to a 60/40 hazelnut oil/cocoa butter filling will reduce saturates by 47% compared with a palm kernel oil filling – and, again, give a better product

Thank you for your attention

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