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# COMPARATIVE TESTS OF TWO DEGLAZING METHODS ON BROCCOLI

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## M1 – PROFEL Method

## M4 – Modified New Welmec Method

To the attention of:

PROFEL
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Tests conducted at PFI Nouvelles-Vagues (Boulogne-sur-Mer, France), August 6th and 7th of 2019

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# SUMMARY

# 1. Context of the study

Since December 2013, the European Association of Fruit and Vegetable Processors (PROFEL) has been working with its members on a scientific methodology to assess the glazing rate on frozen broccoli florets sold on the market.

CTCPA and PFI Nouvelles Vagues support PROFEL in this project. CTCPA is the French technical center for canned and dehydrated foods, and relies on seventy years experience in the area of food processing. This expertise convinced French companies producing frozen vegetables and herbs to join the centre in 2014. The "ITAI" label (Agro-Industrial Technical Institute), obtained since 2007, confirms this expertise and ensures a total neutrality and independence of CTCPA towards suppliers and producers.

The innovative platform Nouvelles-Vagues (PFINV) is an limited company with an executive and a supervisory board, created on October 15th of 2011, specialized in the foodstuff processing and quality-control of seafood products, and into aquaculture research. PFINV is split into 2 departments: "Technology and Analyses" and "Aquaculture". A technological pilot plant and a seafood laboratory belong to the structure. PFINV frequently carries out glazing rate analysis on fishery products, and benefits from a French accreditation on this analysis.

A deglazing method was defined in June 2015 based on laboratory tests, and directly inspired by the method applied on fishery products: immersion of the products in a water bath during a defined time, allowing the glaze to melt but making sure that the broccoli florets remain frozen at core.

A second range of tests conducted in June 2017 led to an adjustment of the method (60 sec of immersion time instead of 30 sec), with satisfactory results on several types of broccoli (origin, size). This method (hereunder named M1 – PROFEL) had been endorsed by PROFEL's members. It was then decided to propose this method to the Welmec (European cooperation in the field of legal metrology).

At the Welmec meeting hosted in London in March 2019, an alternative method (hereunder named M4 – Modified New Welmec Method) was proposed by the German representative. Concerns were raised by PROFEL regarding this alternative method, particularly as all work was carried out exclusively on Ecuadorian origin broccoli. Therefore a new set of trials was quickly and efficiently organized in early August 2019, in order to perform a back-to-back comparison of both methods on glazed samples of various origins, in order to identify the most robust and most accurate method.

The present report describes the methodology implemented for these trials, and the results obtained.

# 2. Materials and methods

## *2.1. Participants*

The trials were carried out at PFI Nouvelles-Vagues laboratory (Boulogne-sur-Mer, Fr.), on August 6$^{th}$ and 7$^{th}$ of 2019. They were performed under the double supervision of Ms. Clémence Millet from CTCPA, and Ms. Véronique Mulak from PFI Nouvelles-Vagues. The other participants were:

- Susanne Meyer, Director General of PROFEL,

- Nigel Thorgrimsson, Ardo & Chairman of PROFEL Technical and Legislative Commitee,
- Martin Hlusek, EU Regulatory Affairs Manager, PROFEL,
- Rosi Martinez, Congelados de Navarra, PROFEL Working Group expert
- Gerardo Adan, Virto, PROFEL Working Group expert
- Jeff Baxter, independant consultant for PROFEL,
- Stefaan Lezy, Metrology Control Attaché and Belgian WELMEC representative.

### *2.2. Types of brocoli*

6 types of brocoli were used for this study:

1. Spain, size 20-40
2. Spain, size 40-60
3. UK, size 20-40
4. UK, size 40-60
5. Ecuador, size 20-40
6. Ecuador, size 30-50

Pictures below show samples of each batch (frozen unglazed brocolis):



We can notice on these pictures that the Ecuadorian florets are smaller than the English and Spanish samples.

### *2.3. Glazing of the samples*

The following samples were prepared:

- 3 glazing rates: target of 0, 10 and 20 % (calculated on the glazed weight)
- 2 methods: M1 and M4
- 3 origins (Ecuador, Spain, UK)

- 2 sizes (20-40 and 30-50/40-60)
- 3 repetitions for each condition

Altogether, 108 samples were prepared: 54 samples coded a (for method M1) and 54 samples coded b (for method M4). An initial weight of approx. 250 g of broccoli was exactly weighed for each sample.

For the 0% glaze, the florets were directly transferred in pre-identified bags, immediately sealed and weighed.

For the 10% glaze, the florets were put in a sieve covered by a lid, then immersed during 3 seconds in water at 14-18°C (tap water). After 10 seconds of draining, the florets were put in a pre-identified bag, immedialetly sealed and weighed.


The protocol is the same for 20% glaze, except that the water used was at 1-4°C.

All the samples were produced on August 6th, then stored in a cold room at -18°C, and used the next day for deglazing tests.

## *2.4. Deglazing of the samples*

### 2.4.1. Method M1 – PROFEL

The initial method as discussed at the last Welmec meeting in March is displayed in Appendix 1. The main steps are summarized here:

1. Put the florets in a 0.5 mm mesh sieve
2. Immerse the sieve in a water bath during 60 sec at 27°C, with gentle hand agitation
3. Remove the sieve and transfer the content in a 2.5 mm mesh sieve (pre-tared)
4. Drain during 2 min at a 17-20° angle
5. Dry off any visible excess water from outer walls and underside of both sieves
6. Weigh the sample and deduct the tared sieve weights

Taking into account Welmec's concerns about the subjectivity of some instructions (especially steps 2 and 5), and after discussion with Mr. Lezy about the weight of wet sieves, the following changes (colored in blue) were applied to the method before performing the tests on the prepared samples:

0. Weigh both sieves (empty) after immersion in the water bath and 2 min draining. Repeat the operation 10 times, and calculate the average "wet weight" of the sieve. Hence wiping of the sieves after draining is no longer required. Subjectivity of this wiping is removed from the method.
1. Put the florets in a 0.5 mm mesh sieve
2. Immerse the sieve in an agitated water bath during 60 sec at 27°C, covering the sieve to prevent florets and crumbs from escaping
3. Remove the sieve and transfer the content in a 2.5 mm mesh sieve ~~(pre-tared)~~

4. Drain during 2 min at a 17-20° angle
~~5. Dry off any visible excess water from outer walls and underside of both sieves~~
5. Weigh the sample and deduct the average wet weight of "both wet sieves", as determined in point 0

In order to compare the results from this method with M4, the deduction of 5% corresponding to the drip loss and variation among samples (maturity, growth conditions, size, density…) **has not been** applied.

The glazing rate was established with the formula:

$$\frac{\text{Weight of glazed Broccoli} - \text{Weight of drained Broccoli}}{\text{Weight of glazed Broccoli}} \times 100$$


Weighing of initial sample in wet sieves

Immersion 60 sec at 27°C in agitated water bath

Draining 2 min 17-20°

### 2.4.2. Method M4 – New Modified Welmec

The full method is described in Appendix 2. The main steps of M4, proposed by German representative of Welmec, are summarized here:

1. Put the florets in a 1 mm mesh sieve
2. Immerse the sieve in a water bath during 180 sec at 35-39°C, with gentle hand agitation
3. Remove the sieve and transfer the content in a 2.5 mm mesh sieve (pre-tared)
4. Drain during 2 min at a 17-20° angle
5. Transfer Broccoli florets on a pre-tared tray or plate
6. Weigh the sample

Again, to avoid any subjectivity on this method, slight changes were made:

1. Put the florets in a 1 mm mesh sieve
2. Immerse the sieve in an agitated water bath during 180 sec at 37°C

3. Remove the sieve and transfer the content in a 2.5 mm mesh sieve (pre-tared)
4. Drain during 2 min at a 17-20° angle
5. Transfer Broccoli florets by hand onto a pre-tared tray or plate
6. Weigh the sample

The glazing rate was established with the same formula than M1:

$$\frac{\text{Weight of glazed Broccoli} - \text{Weight of drained Broccoli}}{\text{Weight of glazed Broccoli}} \times 100$$

Immersion 180 sec at 37°C in agitated water bath

Transfer florets in a pre-tared tray (after draining)

Final weight after deglazing

# 3. Results

## 3.1. Method M1 – PROFEL

| Sample identification | | | Glazing | | | Deglazing | | | Difference | Temp. |
|---|---|---|---|---|---|---|---|---|---|---|
| Broccoli sample | Sample number | Broccoli size | Sample weight before glazing (g) | Sample weight glazed (g) | **% theoric glaze** | Weight before deglazing (storage 24h at -18°C) (g) | Drained (deglazed) weight (g) | **% Deglazed** | **% Deglazed – %theoric glaze** | Florets temp. after deglazing (°C) |
| 1. Spain 20-40 | 11a | 20-40 | 248,9 | 291,08 | **14,49%** | 289,2 | 249,77 | **13,63%** | **-0,86** | NA |
| | 12a | 20-40 | 248,8 | 318 | **21,76%** | 317,1 | 275,24 | **13,20%** | **-8,56** | -10.6 |
| | 13a | 20-40 | 249,7 | 325,66 | **23,32%** | 324,5 | 281,77 | **13,17%** | **-10,16** | NA |
| | 14a | 20-40 | 250,8 | 294,7 | **14,90%** | 294 | 272,84 | **7,20%** | **-7,70** | NA |
| | 15a | 20-40 | 249,6 | 286,21 | **12,79%** | 286,5 | 262,06 | **8,53%** | **-4,26** | -12.6 |
| | 16a | 20-40 | 249,2 | 288,26 | **13,55%** | NA | 266,24 | **7,64%** | **-5,91** | NA |
| | 17a | 20-40 | 251,3 | 251,3 | **0,00%** | 251,3 | 274,97 | **-9,42%** | **-9,42** | NA |
| | 18a | 20-40 | 253,3 | 253,3 | **0,00%** | 252,7 | 271,74 | **-7,53%** | **-7,53** | NA |
| | 19a | 20-40 | 251,5 | 251,5 | **0,00%** | 250,7 | 270,97 | **-8,09%** | **-8,09** | NA |
| 2. Spain 40-60 | 21a | 40-60 | 253,6 | 311,22 | **18,51%** | 310,82 | 292,94 | **5,75%** | **-12,76** | NA |
| | 22a | 40-60 | 247,9 | 312,12 | **20,58%** | 311,8 | 281,87 | **9,60%** | **-10,98** | NA |
| | 23a | 40-60 | 255,7 | 323,92 | **21,06%** | 323,1 | 293,14 | **9,27%** | **-11,79** | NA |
| | 24a | 40-60 | 251,3 | 286,5 | **12,29%** | 286,19 | 277,57 | **3,01%** | **-9,27** | NA |
| | 25a | 40-60 | 251,7 | 289,4 | **13,03%** | 288,25 | 281,34 | **2,40%** | **-10,63** | NA |
| | 26a | 40-60 | 251,4 | 288,2 | **12,77%** | 287,9 | 273,47 | **5,01%** | **-7,76** | NA |
| | 27a | 40-60 | 259,5 | 259,5 | **0,00%** | 259,2 | 285,3 | **-10,07%** | **-10,07** | NA |
| | 28a | 40-60 | 247,1 | 247,1 | **0,00%** | 246,7 | 269,37 | **-9,19%** | **-9,19** | NA |
| | 29a | 40-60 | 255,7 | 255,7 | **0,00%** | 255 | 274,74 | **-7,74%** | **-7,74** | NA |
| 3. UK 20-40 | 31a | 20-40 | 251,6 | 321,8 | **21,81%** | 320,8 | 275,17 | **14,22%** | **-7,59** | -0.9 |
| | 32a | 20-40 | 250,5 | 318,5 | **21,35%** | 317,8 | 273,14 | **14,05%** | **-7,30** | 1.2 |
| | 33a | 20-40 | 249,2 | 314,8 | **20,84%** | 313,1 | 275,97 | **11,86%** | **-8,98** | -1.6 |
| | 34a | 20-40 | 249,6 | 282,3 | **11,58%** | 281,2 | 268,04 | **4,68%** | **-6,90** | -0.8 |
| | 35a | 20-40 | 250,9 | 283,5 | **11,50%** | 282,56 | 269,67 | **4,56%** | **-6,94** | -1.2 |
| | 36a | 20-40 | 249,5 | 287,5 | **13,22%** | 286,6 | 268,55 | **6,30%** | **-6,92** | -0.4 |
| | 37a | 20-40 | 251,8 | 251,8 | **0,00%** | 251,1 | 263,97 | **-5,13%** | **-5,13** | -0.7 |
| | 38a | 20-40 | 250,1 | 250,1 | **0,00%** | 249,6 | 267,34 | **-7,11%** | **-7,11** | -0.3 |
| | 39a | 20-40 | 249,3 | 249,3 | **0,00%** | 248,51 | 262,07 | **-5,46%** | **-5,46** | -0.9 |
| 4. UK 40-60 | 41a | 40-60 | 253,6 | 308,7 | **17,85%** | 307,8 | 274,24 | **10,90%** | **-6,95** | -2.8 |
| | 42a | 40-60 | 254,5 | 310,3 | **17,98%** | 309,5 | 273,97 | **11,48%** | **-6,50** | -1.6 |
| | 43a | 40-60 | 254,2 | 311,5 | **18,39%** | 311,3 | 275,14 | **11,62%** | **-6,78** | -1.8 |
| | 44a | 40-60 | 250,4 | 277,6 | **9,80%** | 276,7 | 265,3 | **4,12%** | **-5,68** | -1.1 |
| | 45a | 40-60 | 249,1 | 273,6 | **8,95%** | 273,1 | 264,84 | **3,02%** | **-5,93** | -1.1 |
| | 46a | 40-60 | 253,6 | 281,2 | **9,82%** | 280,2 | 267,27 | **4,61%** | **-5,20** | -0.8 |
| | 47a | 40-60 | 251,7 | 251,7 | **0,00%** | 251 | 261,24 | **-4,08%** | **-4,08** | -1.2 |
| | 48a | 40-60 | 251,5 | 251,5 | **0,00%** | 251,1 | 256,87 | **-2,30%** | **-2,30** | -1.1 |
| | 49a | 40-60 | 248,2 | 248,2 | **0,00%** | 247,7 | 257,34 | **-3,89%** | **-3,89** | -1.0 |
| 5. Ecuador 20-40 | 51a | 20-40 | 250,9 | 317,8 | **21,05%** | 317,03 | 239,24 | **24,54%** | **3,49** | -0.5 |
| | 52a | 20-40 | 251,4 | 312,3 | **19,50%** | 311,06 | 243,6 | **21,69%** | **2,19** | -1.1 |
| | 53a | 20-40 | 250 | 307,2 | **18,62%** | 306,2 | 243,84 | **20,37%** | **1,75** | -0.2 |
| | 54a | 20-40 | 250 | 280,6 | **10,91%** | 279,9 | 229,57 | **17,98%** | **7,08** | -0.3 |
| | 55a | 20-40 | 249,3 | 285,3 | **12,62%** | 284,5 | 236,34 | **16,93%** | **4,31** | 0.5 |
| | 56a | 20-40 | 251,1 | 287 | **12,51%** | 286,6 | 241,37 | **15,78%** | **3,27** | 0.1 |
| | 57a | 20-40 | 250,8 | 250,8 | **0,00%** | 250,8 | 243,44 | **2,93%** | **2,93** | 13 |
| | 58a | 20-40 | 251,8 | 251,8 | **0,00%** | 251,6 | 244,27 | **2,91%** | **2,91** | 8 |
| | 59a | 20-40 | 251,5 | 251,5 | **0,00%** | 251 | 243,44 | **3,01%** | **3,01** | -0.4 |
| 6. Ecuador 30-50 | 61a | 30-50 | 250,3 | 309,4 | **19,10%** | 309,3 | 266,24 | **13,92%** | **-5,18** | 1.4 |
| | 62a | 30-50 | 254,6 | 307 | **17,07%** | 306,8 | 264,47 | **13,80%** | **-3,27** | -0.7 |
| | 63a | 30-50 | 251,5 | 305,7 | **17,73%** | 305,3 | 259,34 | **15,05%** | **-2,68** | -0.8 |
| | 64a | 30-50 | 251,4 | 278,3 | **9,67%** | 277,9 | 255,07 | **8,22%** | **-1,45** | -1.6 |
| | 65a | 30-50 | 249,8 | 277,3 | **9,92%** | 276,9 | 254,74 | **8,00%** | **-1,91** | -0.3 |
| | 66a | 30-50 | 252,8 | 283 | **10,67%** | 282,4 | 260,87 | **7,62%** | **-3,05** | -2.0 |
| | 67a | 30-50 | 253,7 | 253,7 | **0,00%** | 253,5 | 260,84 | **-2,90%** | **-2,90** | -1.7 |
| | 68a | 30-50 | 250,2 | 250,2 | **0,00%** | 249,9 | 249,97 | **-0,03%** | **-0,03** | -1.0 |
| | 69a | 30-50 | 247,5 | 247,5 | **0,00%** | 247,3 | 250,14 | **-1,15%** | **-1,15** | -1.6 |

## 3.2. Method M4 – New modified Welmec

| Sample identification | | | Glazing | | | Deglazing | | | Difference | Temp. |
|---|---|---|---|---|---|---|---|---|---|---|
| Broccoli sample | Sample number | Broccoli size | Sample weight before glazing (g) | Sample weight glazed (g) | **% theoric glaze** | Weight before deglazing (storage 24h at -18°C) (g) | Drained (deglazed) weight (g) | **% Deglazed** | **% Deglazed – %theoric glaze** | Florets temp. after deglazing (°C) |
| 1. Spain 20-40 | 11b | 20-40 | 250,1 | 318,8 | 21,55% | 317,1 | 259,5 | **18,16%** | -3,38% | 19,8 |
| | 12b | 20-40 | 249,5 | 316,2 | 21,09% | 315,6 | 251,4 | **20,34%** | -0,75% | 29,3 |
| | 13b | 20-40 | 248,9 | 314,8 | 20,93% | 313,6 | 254,7 | **18,78%** | -2,15% | 31,5 |
| | 14b | 20-40 | 249,9 | 286,2 | 12,68% | 286,5 | 252,8 | **11,76%** | -0,92% | 26,8 |
| | 15b | 20-40 | 251,2 | 284,43 | 11,68% | 285,9 | 258,5 | **9,58%** | -2,10% | 31,4 |
| | 16b | 20-40 | 249,6 | 288,78 | 13,57% | 288 | 250,1 | **13,16%** | -0,41% | 22,4 |
| | 17b | 20-40 | 251 | 251 | 0,00% | 250 | 255,8 | **-2,32%** | -2,32% | 27,2 |
| | 18b | 20-40 | 249,8 | 249,8 | 0,00% | 249 | 254,9 | **-2,37%** | -2,37% | 28,4 |
| | 19b | 20-40 | 248,2 | 248,2 | 0,00% | 247,4 | 254,9 | **-3,03%** | -3,03% | 29,6 |
| 2. Spain 40-60 | 21b | 40-60 | 248,6 | 308,42 | 19,40% | 307,9 | 264,9 | **13,97%** | -5,43% | 23 |
| | 22b | 40-60 | 249,7 | 309,82 | 19,40% | 309,4 | 263,2 | **14,93%** | -4,47% | 20,7 |
| | 23b | 40-60 | 251,7 | 309,92 | 18,79% | 308,9 | 259,4 | **16,02%** | -2,76% | 10 |
| | 24b | 40-60 | 250,1 | 288,7 | 13,37% | 288,2 | 257,6 | **10,62%** | -2,75% | 15,2 |
| | 25b | 40-60 | 251,3 | 289 | 13,04% | 288,7 | 259,8 | **10,01%** | -3,03% | 23,2 |
| | 26b | 40-60 | 249,5 | 292,1 | 14,58% | 281,8 | 252,6 | **10,36%** | -4,22% | 19,5 |
| | 27b | 40-60 | 254,2 | 254,2 | 0,00% | 254 | 269,9 | **-6,26%** | -6,26% | 25,4 |
| | 28b | 40-60 | 249,7 | 249,47 | 0,00% | 249,5 | 260 | **-4,21%** | -4,21% | 14,4 |
| | 29b | 40-60 | 251 | 251 | 0,00% | 250,42 | 263,6 | **-5,26%** | -5,26% | 22,2 |
| 3. UK 20-40 | 31b | 20-40 | 251 | 322,8 | 22,24% | 320,9 | 253,1 | **21,13%** | -1,11% | 23,9 |
| | 32b | 20-40 | 249,3 | 315,7 | 21,03% | 314,4 | 249,6 | **20,61%** | -0,42% | 20,2 |
| | 33b | 20-40 | 250,3 | 319,1 | 21,56% | 317,5 | 254,9 | **19,72%** | -1,84% | 21,3 |
| | 34b | 20-40 | 249,9 | 287,3 | 13,02% | 286,4 | 247,6 | **13,55%** | 0,53% | 27 |
| | 35b | 20-40 | 252,6 | 278,7 | 9,36% | 277,2 | 253,6 | **8,51%** | -0,85% | 25,7 |
| | 36b | 20-40 | 250,7 | 277,85 | 9,77% | 275,8 | 249,4 | **9,57%** | -0,20% | 28,1 |
| | 37b | 20-40 | 249,3 | 249,3 | 0,00% | 247,8 | 240,7 | **2,87%** | 2,87% | 26,7 |
| | 38b | 20-40 | 249,5 | 249,5 | 0,00% | 248,7 | 245,2 | **1,41%** | 1,41% | 30,8 |
| | 39b | 20-40 | 253,4 | 253,4 | 0,00% | 252,4 | 251 | **0,55%** | 0,55% | 26,6 |
| 4. UK 40-60 | 41b | 40-60 | 252,4 | 313,3 | 19,44% | 311,6 | 252,5 | **18,97%** | -0,47% | 28,5 |
| | 42b | 40-60 | 249,1 | 305,5 | 18,46% | 304,6 | 249,3 | **18,15%** | -0,31% | 22,2 |
| | 43b | 40-60 | 253 | 307,9 | 17,83% | 306,7 | 250 | **18,49%** | 0,66% | * |
| | 44b | 40-60 | 248 | 278,1 | 10,82% | 277,6 | 245 | **11,74%** | 0,92% | 29,8 |
| | 45b | 40-60 | 252,1 | 285,25 | 11,62% | 284,4 | 242,9 | **14,59%** | 2,97% | 27,3 |
| | 46b | 40-60 | 250,7 | 277,7 | 9,72% | 276,8 | 246,8 | **10,84%** | 1,12% | 26,3 |
| | 47b | 40-60 | 248,6 | 248,6 | 0,00% | 247,5 | 242,4 | **2,06%** | 2,06% | 28,6 |
| | 48b | 40-60 | 254,2 | 254,2 | 0,00% | 252,2 | 242,1 | **4,00%** | 4,00% | 26,3 |
| | 49b | 40-60 | 249,4 | 249,4 | 0,00% | 249 | 246,2 | **1,12%** | 1,12% | 27,2 |
| 5. Ecuador 20-40 | 51b | 20-40 | 252,7 | 311,3 | 18,82% | 309,3 | 228,3 | **26,19%** | 7,36% | 28,5 |
| | 52b | 20-40 | 249,6 | 312,1 | 20,03% | 310,4 | 231,6 | **25,39%** | 5,36% | 25 |
| | 53b | 20-40 | 250,5 | 315,8 | 20,68% | 314,4 | 227,5 | **27,64%** | 6,96% | 29,3 |
| | 54b | 20-40 | 250,3 | 284,1 | 11,90% | 282,7 | 228,2 | **19,28%** | 7,38% | 28,4 |
| | 55b | 20-40 | 251,7 | 280,8 | 10,36% | 278,9 | 220,7 | **20,87%** | 10,50% | 24,4 |
| | 56b | 20-40 | 250 | 281,5 | 11,19% | 279,2 | 228,4 | **18,19%** | 7,00% | 28,1 |
| | 57b | 20-40 | 251 | 251 | 0,00% | 250,5 | 233,4 | **6,83%** | 6,83% | 26,8 |
| | 58b | 20-40 | 252,1 | 252,1 | 0,00% | 251,8 | 237,7 | **5,60%** | 5,60% | 30,3 |
| | 59b | 20-40 | 251,1 | 251,1 | 0,00% | 250,7 | 234,6 | **6,42%** | 6,42% | 30,1 |
| 6. Ecuador 30-50 | 61b | 30-50 | 251 | 305,6 | 17,87% | NA | 238,1 | **22,09%** | 4,22% | 18 |
| | 62b | 30-50 | 249,2 | 302,7 | 17,67% | 301,7 | 236 | **21,78%** | 4,10% | 18,5 |
| | 63b | 30-50 | 252,6 | 304,4 | 17,02% | 303,1 | 244,7 | **19,27%** | 2,25% | 21,3 |
| | 64b | 30-50 | 252,4 | 282,4 | 10,62% | 282 | 236,39 | **16,17%** | 5,55% | 23,8 |
| | 65b | 30-50 | 249 | 274,58 | 9,32% | 273,9 | 232,8 | **15,01%** | 5,69% | 22,5 |
| | 66b | 30-50 | 251,5 | 280,8 | 10,43% | 280,1 | 236,9 | **15,42%** | 4,99% | 25,7 |
| | 67b | 30-50 | 252,9 | 252,9 | 0,00% | 252,3 | 242,4 | **3,92%** | 3,92% | 27,5 |
| | 68b | 30-50 | 249,4 | 249,4 | 0,00% | 249,2 | 240,3 | **3,57%** | 3,57% | 29,1 |
| | 69b | 30-50 | 251 | 251 | 0,00% | 250,7 | 242,9 | **3,11%** | 3,11% | 24 |

## 4. Comparison of both methods

### *4.1. Ice crystals*

Some Ice crysals were observed after the deglazing process.

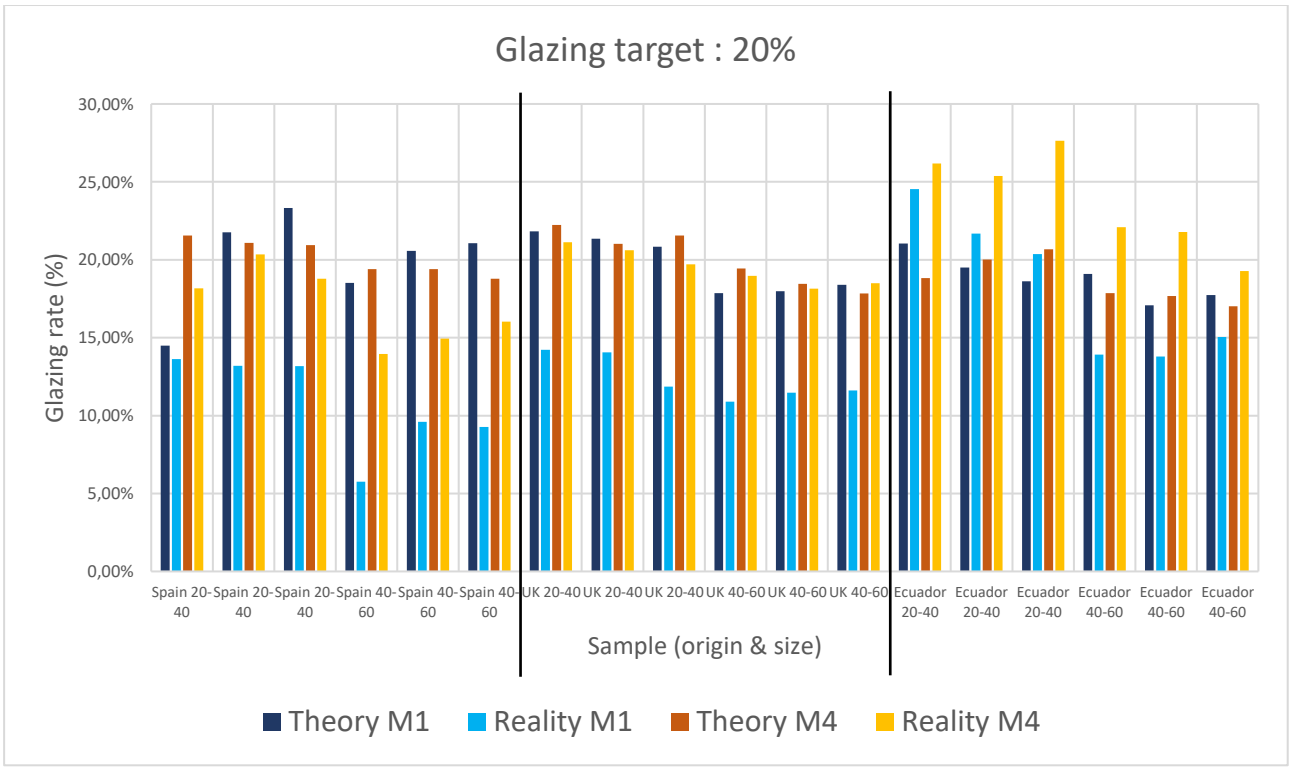

Ice crystals are noticed after the deglazing step by method M1, which is logical as the temperature in the florets varies around 0°C. However, as ice crystals are visible for unglazed products, it cannot be used as a proof of residual glaze in the samples.

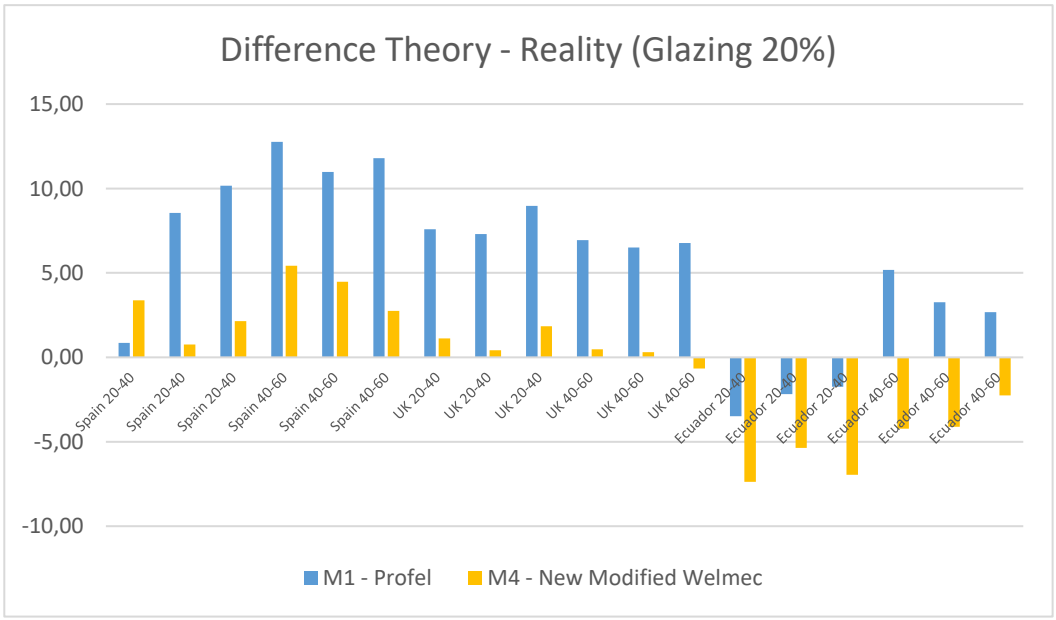
With the method M4, no more ice crystals are visible, since the florets have a temperature of approx. 25°C.

### *4.2. Deglazing results*

To facilitate the interpretation of the results, they are displayed in 3 graphs: one for each glazing rate. Equivalent samples (e.g. 21a and 21b) are represented on the same spot, with blue color for M1 and orange color for M4. The dark bar is the target, the light bar is the reality measured by the corresponding method.

#### 4.2.1. Glazing rate = 20 %



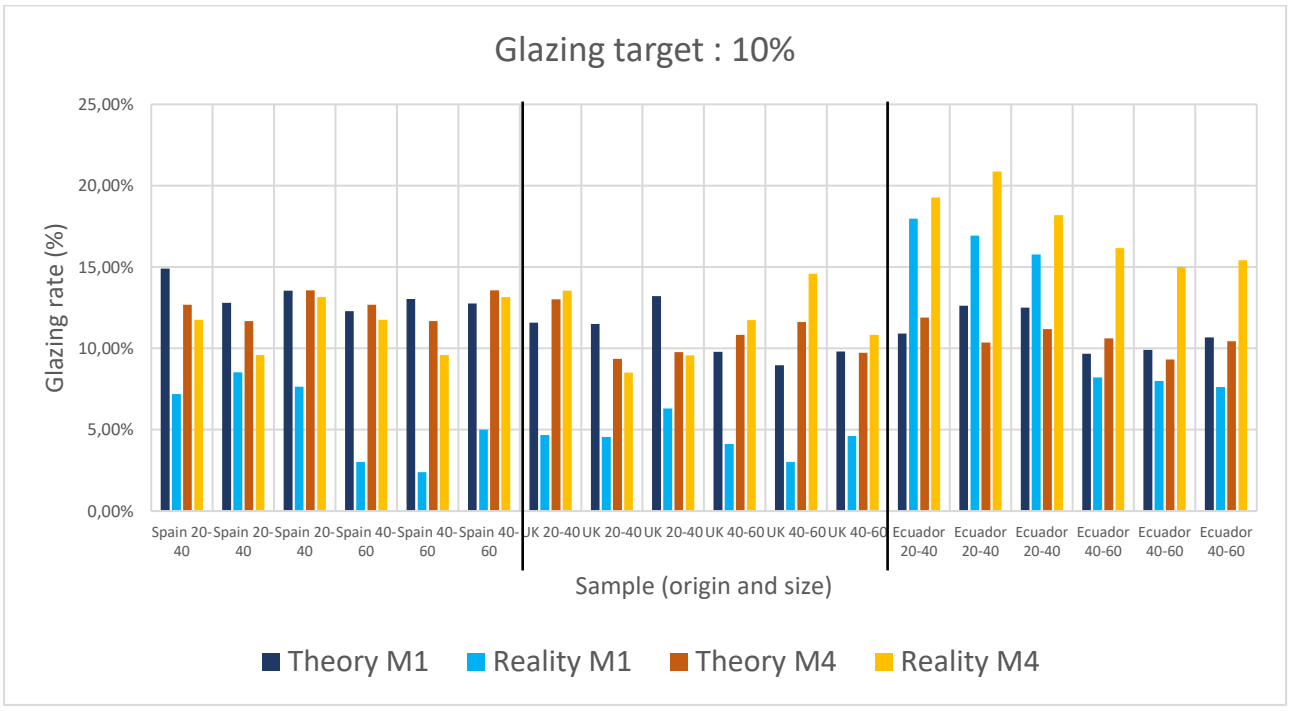
For almost all the Spanish and English samples (except the first on the left), the method M4 gives more accurate results than method M1, whatever the size. The average gap between theory and reality is 8.27 for M1, versus 1.87 for M4. For these two origins, M4 is acknowledged as the most accurate method.

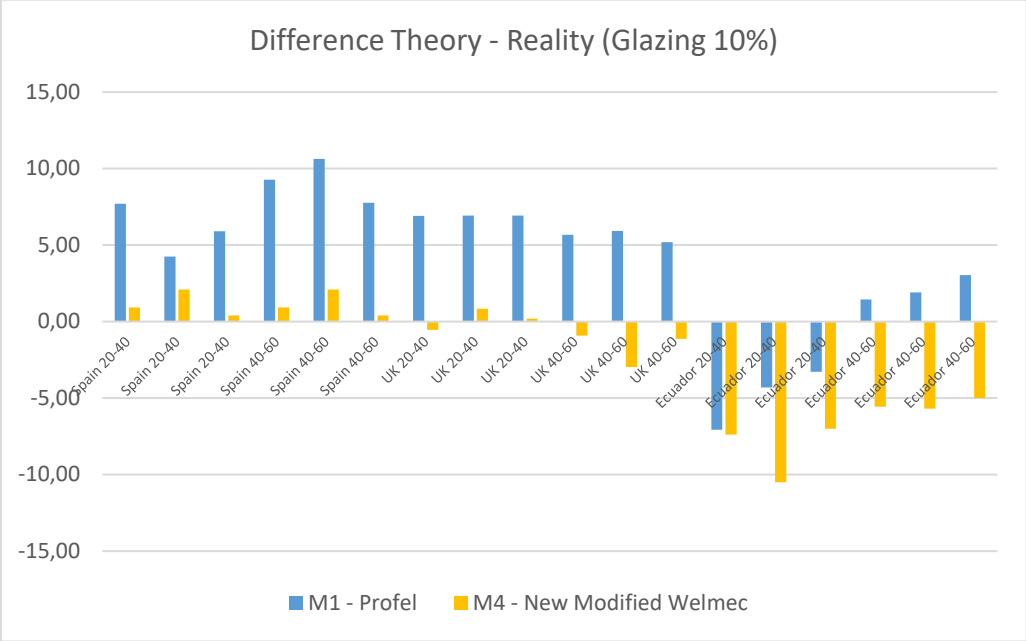
The results obtained from the Ecuadorian broccoli using the WELMEC method M4 were not consistent with the results achieved on the Spanish and UK broccoli samples, in that a higher level of glaze was measured than had been applied by ourselves. Further investigation with the supplier of the Ecuadorian samples revealed that the samples had most probably been lightly glazed, however the glaze level had not been measured by the supplier of the samples.

Making the assumption that the Ecuadorian broccoli had indeed been glazed and taking the results from the WELMEC method for the samples for which we did not add glaze (see chapter 4.2.3. for results on unglazed broccoli), we can establish the level of glaze applied during manufacture: average of 6.28% on 20-40 size, and 3.53% on 30-50 size.

If this level of manufacturer applied glaze is removed from the final glaze levels measured in our trials, then our results using the WELMEC method M4 for the Ecuadorian broccoli fall into line with the results for the UK and Spanish broccoli.

### 4.2.2. Glazing rate = 10%

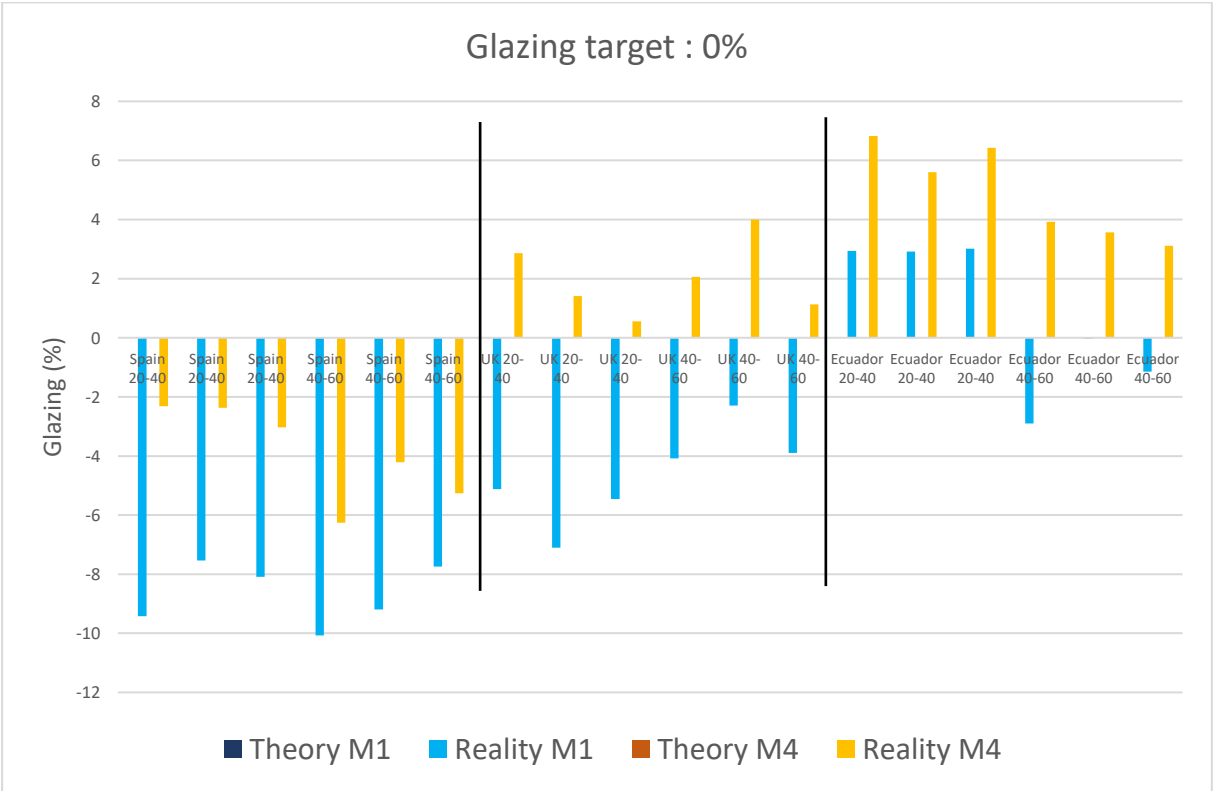


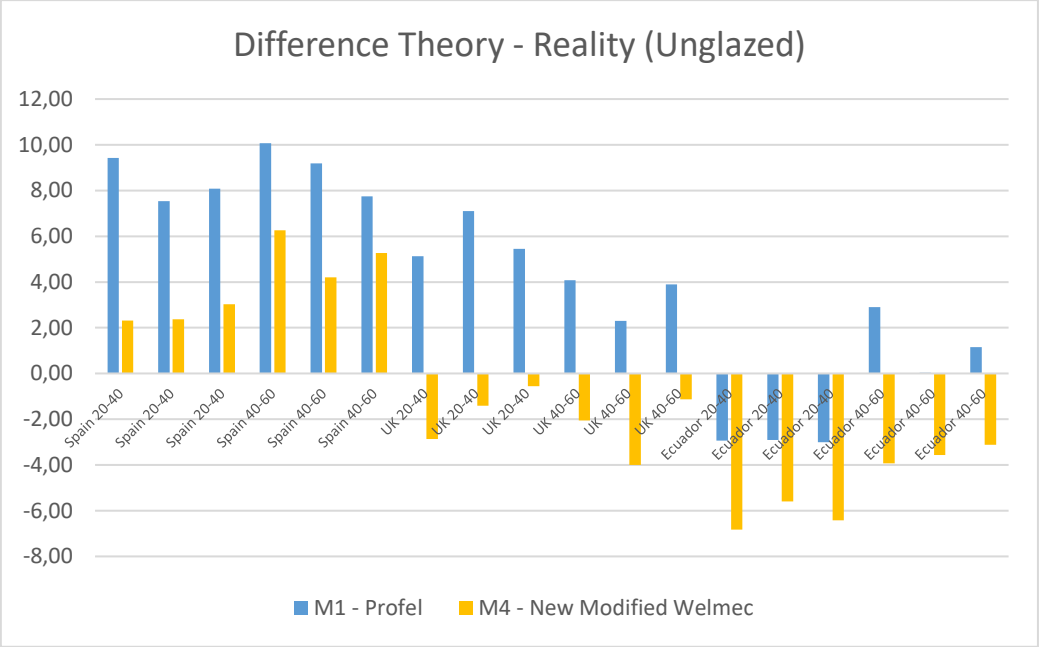



The same conclusion can be expressed for Spanish and English samples glazed at 10 %: the accuracy of method M4 is higher than M1. Average difference between theory and reality is 6.93 % for M1, versus 0.2 % for M4. However, we can notice that on four UK samples out of six, method M4 removes more water than added, which may unfairly disadvantage the processor by considering internal water (i.e. drip loss) as glazing water.

For Ecuadorian samples, when removing the glaze added on raw samples (6.28% on 20-40 size, and 3.53% on 30-50 size), the results of the WELMEC method also align with the targeted glazing rate.

### 4.2.3. Unglazed samples






On unglazed samples, M1 methods creates glaze on the surface of the florets: since these florets are still frozen when leaving the water bath, the captured water freezes on the surface, thus creating negative results. This phenomen is also noticed for M4 samples, but surprisingly only on Spanish samples. Subsequently, we noticed that due to the schedule of the trials out of Broccoli season, the Spanish samples were frozen broccoli which underwent a slight thawing at +4°C during 8h to remove the glaze initialy added. This step may have the consequence that Spanish florets are saturated by water, which is not the case of UK samples.

As mentioned earlier in this report, the Ecuadorian broccoli was believed to have received a light glazing before the glaze added during the trials. An average glazing rate of 6.28% on 20-40 size, and 3.53% on 30-50 size was found on unglazed samples, with the method M4.

## *4.3. Discussion*

### 4.3.1. On the results

In the light of the back-to-back tests performed in PFI Nouvelles-Vagues, and the results displayed above in this report, method M4 is clearly more accurate than M1 on the studied samples. There is no obvious explanation to understand the difference between the inaccurate results of M1 for this trial set, and the accurate results found in 2017, just before presenting the M1 method to the Welmec committee, despite applying the same methodology for both glazing and deglazing.

These differences and the present results confirm that M4 is more likely to measure a correct glazing rate in “blind” samples, where initial glaze is not known (as this will be the case in official controls).

However, performing both methods highlighted some improvements on initial method M4, to eliminate all the subjective interpretations and to increase precision.

First of all, instead of “gentle hand agitation”, we would advise to use an agitated water bath, with a pumping system of the water allowing a circulation of the flow in the bath. Therefore,

there is no risk for the florets to stick together, and no risk for the surrounding water to cool down when introducing the sample in the bath. This type of water bath was used for the present tests.

The other concern relates to the crumbs of broccoli remaining in the sieve, thus not taken into account in the glazing calculation. To avoid this, Mr. Lezy suggested the following methodology: weigh the sieve as wet (repeat 10 times and calculate the average wet weight), then deduct the average wet weight of the sieve from the weight of the sample, after 2 min of draining. Therefore, there is no need to transfer the florets in another container (tray, plate, other), and the crumbs left in the bottom of the sieve are now weighed as product.

### 4.3.2. Variability in fresh Broccoli

As already discussed with and referenced by Welmec, it seems necessary to introduce a tolerance factor for the interpretation of results. This correction factor takes account of both the amount of water consistently found to be retained within unglazed Broccoli, and the measurement uncertainty factor inherent when following the determination protocol. This factor not only takes account of the reproducibility and accuracy of the methodology, but also recognises that Broccoli is a natural product. As such, any tests upon Broccoli will have an inherent variability due to parameters including maturity, origin, climatic growth conditions, processing conditions, size and density that will influence both the freezing and glazing characteristics of the florets. This variability is confirmed by the present tests performed on unglazed broccoli, which give a glazing rate of up to 4 % on UK samples, when this loss should be considered as natural drip loss.
For all these reasons, and in order to avoid unfair penalization of processors, we strongly advise that determinations of up to 5% should be set aside and not be regarded as glaze.

### 4.3.3. Ajustements proposed on M4

Based on all these parameters, hereunder are our suggestions of adjustments to the M4 protocol:

1. Weigh the sieve (empty) after immersion in the water bath and 2 min draining at a 17-20° angle. Repeat the operation 10 times, and calculate the average “wet weight” of the sieve (T0).
2. Remove the bag of Broccoli from a freezer and put a representative sample of approximately 300g in size into the sieve. Take note of exact weight, e.g. 312,4g – T1
3. Fully immerse the sieve plus contents into an agitated Bain Marie containing water at a nominal 35-39ºC for 180 seconds, ~~with gentle hand agitation of the florets and~~ ensuring that the florets are retained within the immersed sieve.
4. Remove the sieve and incline at around 17 - 20º angle, and allow to drain for 2 minutes.
5. Weigh the sieve with the broccolis inside (T2).
6. Deduct the average value of wet weigh of sieve: T2 – T0 = T3, weight of deglazed broccolis.
7. Calculate the percentage of glaze :

$$\left[ \frac{\text{Weight of glazed Broccoli (T1)} - \text{Weight of drained Broccoli (T3)}}{\text{Weight of glazed Broccoli (T1)}} \times 100 \right]$$

1. After completing the above stage 7 remove the visually largest floret and cut it lengthwise in order to examine it for the presence of ice crystals. If any ice crystals can still be seen trapped within the floret head then removal of all applied glaze cannot be guaranteed and the determination of percentage glaze invalid. In such circumstances a further sub-sample must be drawn from the original frozen sample and the complete test repeated – but with the immersion time in the Bain Marie increased by 120 seconds to total of 5 minutes.

2. If, upon first opening the bag of frozen Broccoli, there are noticeable clumps of ice present apart from the broccoli, then this is indicative of the sample having undergone sublimation due to temperature abuse within the distribution chain. No accurate calculation of the glazing level applied can be made on such samples, and these should be discarded.

## 5. Conclusion

These tests were carried out to assess the accuracy and reliability of both methods on comparable samples. At the end, method M4 has emerged as the best method. Adjustements to enhance its accuracy and avoid any subjectivity have been described in chapter 4.3.3.

# APPENDICES

# APPENDIX 1

*Method M1*

PROFEL

EUROPEAN ASSOCIATION OF
FRUIT AND VEGETABLE PROCESSORS

ORGANISATION EUROPÉENNE DES INDUSTRIES
TRANSFORMATRICES DE FRUITS ET LÉGUMES

Brussels, 5th April 2018
PROFEL.2018.014

**PROTOCOL : Determination of Glazing Level applied to Frozen Broccoli Florets**

***EQUIPMENT***

1. Balance - to accuracy of 0.1g
2. Large Mesh Sieve – diameter 20cm, typical wall height 32mm and square 2.5mm mesh
3. Small Mesh Sieve – diameter 20cm, typical wall height 32mm and square 0.5mm mesh
4. Bain Marie (large enough to completely immerse large sieve), with thermostatic heating control
5. Timer
6. Thermometer
7. Drying cloth or paper towel

**NB all weighing are recorded to an accuracy of 1 decimal place**

***METHODOLOGY***

1. Remove the bag of Broccoli from a freezer and draw a representative sample of approximately 250g in size
2. Tare both sieves together, and then place the drawn sample of frozen Broccoli across the small mesh sieve and record the weight of the sample – T1
3. Fully immerse the small mesh sieve plus contents into the Bain Marie containing water at a nominal 27°C for 60 seconds, with gentle hand agitation of the florets and ensuring that both the florets and any loose crumb are retained within the immersed sieve.
4. Remove the sieve and transfer the contents into the pre-tared large mesh sieve, with the fragments staying in the small mesh sieve
5. Incline both sieves at a 17 - 20° angle, and allow to drain for 2 minutes.
6. Carefully dry off any visible excess water from the outer walls and undersides of both sieves using a cloth / paper towel.
7. Reweigh the drained Broccoli plus sieves and deduct the tared sieve weights, to give the weight of deglazed Broccoli – T2
8. Calculate the apparent percentage glaze, and from this deduct 5% to obtain the actual percentage glaze :

$$\left(\frac{Wt\ of\ Glazed\ Broccoli\ (T1) - Wt\ of\ Drained\ Broccoli\ (T2)}{Wt\ of\ Glazed\ Broccoli\ (T1)} * 100\right) - 5$$

= Actual Percentage Glaze

**NB:** If, upon first opening the bag of frozen Broccoli, there are noticeable clumps of ice present then this is indicative of the sample having undergone sublimation due to temperature abuse within the distribution chain. No accurate calculation of the glazing level applied can be made on such samples, and these should be discarded.

***INTERPRETATION OF RESULTS***

- The 5% deduction from the apparent glazing percentage to obtain the actual glazing percentage is a correction factor to take account of both the amount of water consistently found to be retained within unglazed Broccoli, and the measurement uncertainty factor inherent when following the determination protocol.

- This uncertainty factor not only takes account of the reproducibility and accuracy of the methodology, but also recognises that Broccoli is a natural product. As such, any tests upon Broccoli will have an inherent variability due to parameters including maturity, origin, climatic growth conditions, processing conditions, size and density that will influence both the freezing and glazing characteristics of the florets.

**PROFEL – April 2018**

# APPENDIX 2

*Method M4*

# Proposal of "Modified New Welmec Method" for determination of Glazing Level applied to Frozen Broccoli Florets (by STP)

## EQUIPMENT

1. Balance - to accuracy of 0.1g
2. Small Mesh Sieve – diameter 20cm, typical wall height 32mm and square mesh size 1mm
3. Bain Marie (large enough to completely immerse large sieve), preferably with thermostatic heating control
4. Timer
5. Thermometer
6. Tray/plate

**NB all weighing are recorded to an accuracy of 1 decimal place**

## METHODOLOGY

1. Put sieve on scale and set the scale to zero.

2. Remove the bag of Broccoli from a freezer and put a representative sample of approximately 300g in size into the sieve. Take note of exact weight, e.g. 312,4g – T1

3. Fully immerse the sieve plus contents into the Bain Marie containing water at a nominal 35-39$^{o}$C for 180 seconds, with gentle hand agitation of the florets and ensuring that they are retained within the immersed sieve.

4. Remove the sieve and incline at around 17 - 20$^{o}$ angle, and allow to drain for 2 minutes.

5. Put the small tray or plate on the scale and set it to zero

6. Take Broccoli Florets out of the sieve and put on the tray/plate that is on the scale. Take note of the indicated weight. (=T2)

   Any small fragments or dust from the sieve should be taken out of the sieve as well by hitting it up-side-down (however it is not mandatory as trials have shown that this is maximum 1% weight).

7. Calculate the percentage glaze :

$$\frac{\text{Wt of Glazed Broccoli (T1)} - \text{Wt of Drained Deglazed Broccoli (T2)}}{\text{Wt of Glazed Broccoli (T1)}} \times 100$$

**NB**

1. After completing the above stage 7 remove the visually largest floret and cut it lengthwise in order to examine it for the presence of ice crystals. If any ice crystals can still be seen trapped within the floret head then removal of all applied glaze cannot be guaranteed and the determination of percentage glaze invalid. In such circumstances a further sub-sample must be drawn from the original frozen sample and the complete test repeated – but with the immersion time in the Bain Marie increased by 120 seconds to total of 5 minutes.

2. If, upon first opening the bag of frozen Broccoli, there are noticeable clumps of ice present apart from the broccoli, then this is indicative of the sample having undergone sublimation due to temperature abuse within the distribution chain. No accurate calculation of the glazing level applied can be made on such samples, and these should be discarded.

## INTERPRETATION OF RESULTS

Broccoli is a natural product. Each floret is different in size, percentage of head versus stalk (inside head more water can be trapped/glazed than on the firm stalk…), - and also maturity and processing method can vary slightly witch may influence both the freezing and glazing characteristics of the florets. Therefore we believe an in-accuracy of 2-3% may occur and should be tolerated.