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Contents of capsaicinoids in chillies grown in Denmark

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Abstract
We have studied 15 different cultivars of chillies (Capsicum var.) grown in temperate climate Denmark and determined the contents of the four major capsaicinoids: capsaicin, dihydrocapsaicin, nordihydrocapsaicin, and homocapsaicin. From these contents we have, as commonly done for chillies, calculated the so-called pungency in Scoville heat units in order to compare with previous studies from other climatical zones. For three of the investigated cultivars, Serrano, Habanero and BIH Jolokia, for which reliable pungencies has previously been reported, we have found pungencies of 34 000 ± 1400, 247 000 ± 24 000 and 665 000 ± 4000, respectively, which are all in the same ranges as found earlier for chillies grown in more traditional chilli growing areas. Furthermore we have found that the relative distribution of the four capsaicinoids in the 15 different cultivars is highly variable, with the content of capsaicin ranging from 31 % to 71 % of the total capsaicinoid content.

Keywords: Chilli peppers, capsaicinoids, Capsicum var., LC-MS

1. Introduction
Chilli peppers, or just chillies, are the pungent, colourful fruits from plants of the genus Capsicum in the nightshade family, Solanaceae. The fruits are commonly used to give a pungent or hot sensation to many different dishes

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and food products all around the world, and they are especially prominent in the Asian and Central-American cuisine.

The compounds responsible for the pungent, hot sensation belong to the group of secondary metabolites known as capsaicinoids. The main compounds in this group are capsaicin ((E)-N-[(4-hydroxy-3-methoxyphenyl)-methyl]-8-methylnon-6-enamide, Cap), dihydrocapsaicin (N-[(4-hydroxy-3-methoxyphenyl)methyl]-8-methylnonanamide, DHCP), nordihydrocapsaicin (N-[(4-hydroxy-3-methoxyphenyl)methyl]-7-methyloctanamide, NDHCP), and homocapsaicin ((E)-N-[(4-hydroxy-3-methoxyphenyl)methyl]-9-methyldec-7-enamide, HCap). The corresponding structures are shown in Fig. 1.

The total content of capsaicinoids in chillies is usually expressed in terms of the so-called pungency that is a weighted sum of the concentrations of the capsaicinoids. This sum is due to historical reasons calculated in Scoville heat units (Shu), which stems from the original organoleptic test for the pungency of chillies (Scoville, 1912). In this test, a defined amount of chilli is extracted with ethanol, which then is subsequently diluted repeatedly until the pungent sensation no longer can be felt on the tongue. The number of times the extract has to be diluted is then taken as the pungency in units of Shu. This experimentally rather cumbersome organoleptic analysis can conveniently be replaced by directly measuring the capsaicinoid content with either GC (gas chromatography) or HPLC (high-performance liquid chromatography), see e.g., (Collins et al., 1995; Kozukue et al., 2005; Todd...
et al., 1977; Thomas et al., 1998). The conversion between concentration of capsaicinoids determined by the analytical methods and the Scoville scale is possible as the pungency of the pure compounds has been determined by Todd et al. (1977) for the capsaicinoids in Fig. 1.

Despite the fact that chillies now are grown in many different areas with different climates and soil conditions, only very limited, systematic knowledge of the influence of growth conditions on the capsaicinoid content is available. In the most detailed study so far 14 different cultivars were grown at four different sites in Bhutan and Thailand (Gurung et al., 2011). This study showed that soil conditions did not significantly influence the yield and pungency of chillies. Rather surprisingly it was demonstrated that there was a negative correlation between increasing temperature and capsaicinoids content. The same reciprocal relation was found between sunlight and capsaicinoids content. This unexpected relation was explained by the fact that higher temperature and more sunlight would increase the growth of the leaves and stems on the expense of the formation of capsaicinoids. But the correlations are complex as different cultivars responded differently to the different environments, and especially the mild cultivars exhibited large variations.

In the present work we have determined the content of the four most abundant capsaicinoids in 15 different cultivars of chillies grown in Denmark that has a temperate climate with a lower temperature than typically found in traditional chilli growing areas. The investigated chillies covers a broad range in pungency. Ranging from the mild varieties, like Espellette, to the extremely pungent cultivars, like the Caroline Reaper that currently is the cultivar with the highest recorded pungency in the world (Lynch, 2015). The investigated chillies are listed in Table 1. For several of these cultivars the capsaicinoid content, and hence the pungency, has not been determined by a trustworthy method until now. Therefore this work will, besides providing information on the effect of growing chillies in an unusual climate, also expand the number of reliably investigated cultivars.

2. Materials and Methods

2.1. Chemicals

Ethanol was of 96% pure technical quality from VWR Prolabo (Radnor, PA). Acetonitrile was of LC-MS grade from Fisher Scientific (Thermo Fischer Scientific, Waltham, MA). The used 20 mM ammonium formate solution was prepared by mixing appropriate amounts of formic acid of LC-MS grade
Table 1: *Capsicum* cultivars analysed in the present work.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Species</th>
<th>Cultivar</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>C. annuum</em></td>
<td>Espelette</td>
</tr>
<tr>
<td>2</td>
<td><em>C. annuum</em></td>
<td>Toftegaard Hot Banana</td>
</tr>
<tr>
<td>3</td>
<td><em>C. annuum</em></td>
<td>Serrano</td>
</tr>
<tr>
<td>4</td>
<td><em>C. baccatum</em></td>
<td>Aji Verde</td>
</tr>
<tr>
<td>5</td>
<td><em>C. baccatum</em></td>
<td>Omnincolor</td>
</tr>
<tr>
<td>6</td>
<td><em>C. baccatum</em></td>
<td>Toftegaard Lemon Chili</td>
</tr>
<tr>
<td>7</td>
<td><em>C. chinense</em></td>
<td>Carolina Reaper</td>
</tr>
<tr>
<td>8</td>
<td><em>C. chinense</em></td>
<td>Fatali</td>
</tr>
<tr>
<td>9</td>
<td><em>C. chinense</em></td>
<td>Habalokia, Yellow</td>
</tr>
<tr>
<td>10</td>
<td><em>C. chinense</em></td>
<td>Habanero</td>
</tr>
<tr>
<td>11</td>
<td><em>C. chinense</em></td>
<td>Red Savina</td>
</tr>
<tr>
<td>12</td>
<td><em>C. chinense</em></td>
<td>Trinidad Scorpion</td>
</tr>
<tr>
<td>13</td>
<td><em>C. chinense</em> x <em>C. frutescens</em></td>
<td>BIH Jolokia, improved strain II</td>
</tr>
<tr>
<td>14</td>
<td><em>C. chinense</em> x <em>C. frutescens</em></td>
<td>Buth Orange Copenhagen</td>
</tr>
<tr>
<td>15</td>
<td><em>C. frutescens</em></td>
<td>Tabasco</td>
</tr>
</tbody>
</table>
(VWR Prolabo) and 26% aqueous ammonium hydroxide solution of LC-MS grade (Fluka, Sigma-Aldrich, St. Luis, MO) in ultra pure water prepared by a Millipore Milli-Q integral 5 unit (Merck Millipore, Darmstadt, Germany). The capsaicin and dihydrocapsaicin standards were from Sigma-Aldrich.

2.2. Fruits

All fruits (See Table 1) were grown at nursery Toftegaard (Køge, Denmark), except the Buth Orange Copenhagen which was from Bjarne’s Seeds and Plants (Videbæk, Denmark). The chilli seeds were planted in January 2015, and in March 2015 they were pricked into 12 cm plant pots. During this period the plants where kept in a greenhouse with minimal heating, i.e. keeping it frost-free. In May 2015 the plants were moved into 10 L pots containing a mixture of sphagnum and soil. They were subsequently grown in an unheated greenhouse without artificial light. All fruits were harvested in October 2015 when ripe, and then stored in closed plastic bags for a maximum of 5 days in a cold room at 4°C to 7°C before analysis.

In the growth period the monthly mean temperature varied from 2.1°C in February to 17.4°C in August. After this the mean temperatures dropped to 9.5°C in October. The exposure to sunshine ranged from 60 h/month in February to 242 h/month in August. Data for all months are given in Supplementary Material Fig 1. All weather data were obtained from The Danish Meteorological Institute (DMI) (Danish Meteorological Institute, 2016)

2.3. Extraction of Capsaicinoids

The stalk of the fruits was snapped off and any remaining green parts were removed with a scalpel and discarded. The fruits were then cut into small pieces and transferred to a porcelain mortar, where they were frozen with liquid nitrogen and then crushed. Approximately 1 g of the fresh, crushed fruits was transferred to a 15 mL centrifuge tube (VWR) and 10 mL of ethanol was added with an Eppendorf Multipette Stream pipette (Eppendorf AG, Hamburg, Germany). The tubes were vortexed for 5 sec and shaken for 15 min at 25°C in a Biosan ES-20 incubator (Biosan Riga, Latvia). Subsequently they were sonicated for 30 min in a Elmasonic P60H bath sonicator (Elma Schmidbauer GmbH, Singen, Germany) at room temperature. After centrifugation for 5 min at 5000 rpm in an Thermo Scientific CR3i centrifuge (Thermo Scientific, Waltham, MA, USA) in order to sediment solid parts, the extract was filtered through an 0.2 μm PTFE syringe filter (Sartorius AG, Göttingen, Germany). All extractions were made in triplicate.
2.4. Analysis of Capsaicinoids

The extracts were analysed on a Shimadzu LC20 Promince HPLC (Shi-
madzu, Kyoto, Japan) equipped with a low-pressure mixing valve in a LC20AD
pump, an SIL-20A autosampler, an LC-10 Column oven, and an SPD 20A
dual wavelength UV detector. After that, a RF20A fluorescence detector
and a LCMS 2020 Single quadrupole mass spectrometer were connected via
a homebuilt 1:1 flow splitter (Consisting of an Idex P-714 PEEK tee assem-
ibly, IDEX Health & Science, Oak Harbor, WA, USA). The LCMS 2020 was
equipped with an electrospray interface (ESI). The capsaicinoids were sep-
arated on a Phenomenex Kinetex EVO C18 2.6 µm 150 mm × 3 mm column
(Phenomenex, Torrance, CA) by an isocratic flow consisting of 40 % ace-
tonitrile and 60 % of 20 mM ammonium formate in water. The flow rate was
0.3 mL min⁻¹. Capsaicinoids were detected in the UV detector at 210 nm and
280 nm. In the fluorescence detector they were detected with an excitation
wavelength of 280 nm and emission wavelength of 325 nm. All quantifica-
tions were performed with one of those detectors. The MS detector was
used for identification of the capsaicinoids. The MS was operated in positive
mode and the scan range was 250-600 m/z with an event time of 1 s. Indi-
vidual compounds were identified by the use of the mass, determined from
the MS detector, and by comparing the relative elution order on a reverse
phase column (Kozukue et al., 2005; Daood et al., 2015). All capsaicinoids
were quantified by the standard curve obtained for capsaicin. This means in
principle that all concentrations would be given in capsaicin equivalents, but
since the chromophore in all capsaicinoids is the vanillylamine, the calibra-
tion curve can be used for all investigated compounds when working in mole
based units.

UV-Vis spectra for quantification of the capsaicinoids standards solu-
tions were obtained on a Nanodrop UV-100 (Thermo Fisher Scientific, Wilm-
ington, DE) and concentrations were determined by the molar extension co-
efficient, ε, of 2500 M⁻¹ cm⁻¹ at 281 nm (O’Neil, 2011).

Moisture content was measured from approximately 1 g to 1.5 g of
the crushed fruits on a Shimadzu MOC-120H moisture balance operating
at 120 °C.

The pungency in Scoville heat units was calculated as follows: First the
molar concentration was converted to a mass based unit, ppm, based on the
dry weight. The dry weight was calculated from the wet weight by use of
the determined moisture content. The total pungency was then calculated
by multiplying the pungency of the pure compounds with the concentrations
and finally these were summed (Todd et al., 1977).

3. Results

With the used isocratic separation we achieved baseline separation of
the four investigated capsaicinoids for all the investigated samples with an
excellent signal-to-noise ratio. This is illustrated by the chromatogram of
sample 6 shown in Fig. 2A, where the UV trace at 210 nm is shown. Almost
identical chromatograms were obtained at 280 nm, albeit with lower intensity,
and from the fluorescence detector, where the intensity was higher and for
several samples the detector was saturated (data not shown). The two main
peaks in the chromatogram (labelled 2 and 3) correspond to Cap and DHCP,
respectively. They were both identified by comparison with an authentic
standard and from there MS spectra (see below). The two minor peaks,
1 and 4, were identified as NDHCP and HCap, respectively, based on the
following: 1) their know retention relative to the Cap and DHCP (Kozukue
et al., 2005; Daoood et al., 2015), 2) the fact that NDHCP and HCap are
fluorescent, and 3) their respective MS spectra (see below).

In Fig. 2B the total ion chromatogram (TIC) and the extracted ion chro-
matograms (XIC) for the relevant m/z values are shown. Also the TIC shows
a good separation of the relevant peaks for all samples. The MS spectra of the
individual compounds are shown in Fig. 2 C-F. In all cases two signals were
observed corresponding respectively to the [M+H]+ and [M+MeCN+H]+
ions. The relative intensity of the two peaks varies, so that for NDHCP and
DHCP the [M+MeCN+H]+ is the most intense peak, whereas for Cap and
HCap both peaks are of similar intensity.

The capsaicinoids concentrations in the fruits were quantified from the
fluorescence signal for the low pungency samples, 1-6, and from the UV trace
at 210 nm for the rest. The fluorescence data were chosen for analysing the
low-pungency samples, as the fluorescence detector had a better response,
thereby allowing for a better quantification of the minor compounds, NDHCP
and HCap. For the other, more pungent chilies the UV data were chosen
since the major peaks were saturated in the fluorescence detector and the
minor peaks had an appropriate intensity in the UV-detector.

The concentrations found for the four capsaicinoids in the analysed chilies
are given in table 2. The found concentration of Cap ranges from 0.7 ± 0.2
\(\mu\)mol g\(^{-1}\) dw for the mildest chilies, the Espelette cultivar (sample 1), to
Figure 2: Chromatograms and MS spectra of sample 6, Toftegaard Lemon Chilli. A) The chromatogram obtained with UV detection at 210 nm. The enumerated peaks correspond to the four major capsaicinoids with 1=NDHCP, 2=Cap, 3=DHCp, and 4=HCap. B) The chromatograms obtained from the MS detector. TIC and the XIC are shown for the major peaks in the mass spectra. C-F) The background-corrected mass spectra of peaks 1 - 4. C) MS spectrum of peak 1 showing the [M+H]^+ and the [M+MeCN+H]^+ peaks of NDHCP. D) MS spectrum of peak 2 showing the [M+H]^+ and the [M+MeCN+H]^+ peaks of Cap. E) MS spectrum of peak 3 showing the [M+H]^+ and the [M+MeCN+H]^+ peaks of DHCP. F) MS spectrum of peak 4 showing the [M+H]^+ and the [M+MeCN+H]^+ peaks of HCap.
Table 2: Concentration of the analysed capsaicinoids in µmole/g dry weight, moisture and pungency of the investigated chillies. Numbers are mean (n=3) ± 1 SD except for moisture.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Cultivar</th>
<th>Cap</th>
<th>DHCP</th>
<th>NDHCP</th>
<th>HCap</th>
<th>Moisture%</th>
<th>Pungency/Shu</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Espelette</td>
<td>0.69±0.15</td>
<td>0.66±0.17</td>
<td>0.41±0.03</td>
<td>0.47±0.07</td>
<td>80.2</td>
<td>9000±1800</td>
</tr>
<tr>
<td>2</td>
<td>Toftegaard</td>
<td>1.25±0.10</td>
<td>1.02±0.09</td>
<td>0.79±0.10</td>
<td>0.83±0.10</td>
<td>86.5</td>
<td>15000±5300</td>
</tr>
<tr>
<td>3</td>
<td>Serrano</td>
<td>3.61±0.13</td>
<td>2.30±0.06</td>
<td>0.63±0.03</td>
<td>1.16±0.04</td>
<td>79.0</td>
<td>34000±1400</td>
</tr>
<tr>
<td>4</td>
<td>Aji Verde</td>
<td>3.10±0.77</td>
<td>1.61±0.30</td>
<td>0.54±0.01</td>
<td>0.66±0.02</td>
<td>80.5</td>
<td>26000±2800</td>
</tr>
<tr>
<td>5</td>
<td>Omnincolor</td>
<td>4.71±0.35</td>
<td>6.66±0.48</td>
<td>0.72±0.04</td>
<td>1.79±0.12</td>
<td>79.9</td>
<td>62000±13000</td>
</tr>
<tr>
<td>6</td>
<td>Toftegaard</td>
<td>4.63±0.25</td>
<td>4.87±0.29</td>
<td>0.69±0.05</td>
<td>0.92±0.04</td>
<td>77.9</td>
<td>51000±28000</td>
</tr>
<tr>
<td>7</td>
<td>Carolina Reaper</td>
<td>131.76±12.13</td>
<td>68.47±10.01</td>
<td>11.40±1.88</td>
<td>13.12±2.48</td>
<td>85.9</td>
<td>1046000±34000</td>
</tr>
<tr>
<td>8</td>
<td>Fatali</td>
<td>27.18±5.04</td>
<td>6.77±1.16</td>
<td>1.88±0.30</td>
<td>2.15±0.33</td>
<td>85.8</td>
<td>17000±700</td>
</tr>
<tr>
<td>9</td>
<td>Habalokia, Yellow</td>
<td>51.85±9.35</td>
<td>28.35±6.07</td>
<td>5.35±1.01</td>
<td>4.14±0.71</td>
<td>86.6</td>
<td>418000±11000</td>
</tr>
<tr>
<td>10</td>
<td>Habanero</td>
<td>33.01±6.09</td>
<td>14.41±2.93</td>
<td>3.00±0.57</td>
<td>2.71±0.51</td>
<td>85.5</td>
<td>247000±25000</td>
</tr>
<tr>
<td>11</td>
<td>Red Savina</td>
<td>36.79±4.71</td>
<td>11.41±1.79</td>
<td>2.06±0.19</td>
<td>1.68±0.15</td>
<td>86.0</td>
<td>246000±80000</td>
</tr>
<tr>
<td>12</td>
<td>Trinidad Scorpion</td>
<td>98.12±2.08</td>
<td>34.44±2.63</td>
<td>3.77±0.17</td>
<td>5.41±0.38</td>
<td>86.0</td>
<td>673000±120000</td>
</tr>
<tr>
<td>13</td>
<td>BIH Jolokia, improved strain II</td>
<td>95.64±2.86</td>
<td>35.42±1.77</td>
<td>5.05±0.34</td>
<td>3.67±0.18</td>
<td>85.9</td>
<td>665000±4000</td>
</tr>
<tr>
<td>14</td>
<td>Buth Orange Copenhagen</td>
<td>67.09±2.74</td>
<td>43.89±3.98</td>
<td>5.05±0.38</td>
<td>3.15±0.15</td>
<td>85.1</td>
<td>566000±47000</td>
</tr>
<tr>
<td>15</td>
<td>Tabasco</td>
<td>16.61±1.49</td>
<td>6.63±0.66</td>
<td>1.46±0.12</td>
<td>1.03±0.07</td>
<td>68.2</td>
<td>120000±32000</td>
</tr>
</tbody>
</table>

Note: Sample numbers correspond to sample codes in the figure.
The relative amounts of the four capsaicinoids found in the investigated chillies in mol%.

131 ± 12 µmol g$^{-1}$ dw for the strongest cultivar, the Carolina Reaper (sample 7). In general, the found concentrations are proportional to the expected pungency.

The relative amounts of the four capsaicinoids in the 15 different samples investigated are given in Fig. 3. In samples 5 and 6, DHCP is the most abundant capsaicinoid, whereas in all other samples Cap has the highest concentration. In general, a complex picture emerges when looking at the relative amounts. For the major compounds we find the Cap relative amount to range from 31% in sample 1 (Espellete) to 71% in sample 11 (Red Savina). The DHCP relative amounts are in the range of 18% (sample 8, Fatali) to 48% in sample 5 (Omnincolor). When comparing the numbers there appears to be a tendency for fruits with lower pungency to contain lower relative amounts of Cap and DHCP, although the relationship is not clear.

In order to facilitate comparison between our measurements and data reported in the existing literature, we have calculated the pungency in Scoville heat unit (Shu) from the found capsaicinoids concentrations. They are all given in Table 2.

The moisture content of the investigated chillies is also given in Table 2 and ranges between 68% for sample 15 to 87% for sample 9.
4. Discussion

By employing a HPLC-MS method to analyse the contents of the different chili samples studied in the present work we were able to separate the four investigated capsaicinoids with a resolution needed for a trustworthy quantification. Although faster methods have been published (Daood et al., 2015; Sganzerla et al., 2014) we chose this method, because it gave sufficient resolution of all four capsaicinoids peaks on the used equipment, and a higher throughput was not needed for the limited number of samples investigated here. The use of both the UV and fluorescence detector allowed for an analysis of both low- and high-pungency chillies in the same run without dilution. The use of the MS detector also allowed for an unambiguous identification of all of the analytes.

It is of interest to compare the pungencies of the chillies grown in Denmark with data obtained from studies of chillies grow in other areas. However, several parameters can influence the value reported for the pungency and make it vary from study to study. For instance, several publications use only Cap and DHCP for the calculation of pungency (see, e.g., Orellana-Escobedo et al. (2013); Juangsamoot et al. (2012)), a procedure that could underestimate the pungency with up to 35 %, which is the relative amount of the other capsaicinoids found in the present study. Furthermore there is also variations as to which part of the fruits to include in the analysis and in the applied drying method.

Although many papers report pungency of chillies, the large and growing number of cultivars studied unfortunately results in that many papers tend only to report data on new cultivars, and only few repeat and compare with measurements of previously investigated cultivars. Moreover, many reports do not provide sufficient detailed information on the investigated cultivar to unambiguously identify it. Below we compare our data with previously published data on cultivars that unambiguously can be identified as the same as those studied in the present work.

For the Serrano cultivar (sample 3) we find a pungency of 34 000 ± 1400 Shu whereas a chilli grown in Mexico had a pungency of 51 000 (Alvarez-Parrilla et al., 2010), and one grown in Washington, USA, had a pungency of 43 000 Shu (Thomas et al., 1998). A substantial lower value of 21 000 Shu was found for a chilli grown in Northern Italy (Giuffrida et al., 2013). These data place the chillies grown in Denmark in the middle of the expected range.

For the more pungent Habanero cultivar (sample 10) a large number
of studies exist. Recently Sweat et al. (2016) has compiled the data and
the found an average pungency of 231 000 ± 122 000 Shu from the published
literature. We find a pungency of 247 000 ± 24 000 for the chillies grown in
Denmark, which again is within the expected range.

Sweat et al. (2016) has also investigated the BIH Jolokia (sample 13)
and found an average value from the literature of 563 000 ± 381 000 Shu. We
find a pungency of 664 000 ± 4000 Shu, which also for this cultivar places the
Danish chilli within in the range found in other areas.

Finally there is also published work on the pungency of Fatali (sample
8) and Tabasco (sample 15). For the Fatali cultivar a pungency of approx-
imately 15 000 Shu was found for a chilli grown in Brazil (de Aguiar et al.,
2016). For the Tabasco cultivar a pungecy of 17 000 Shu was found when
grown in Washington, USA, and a value of 21 000 Shu was found when grown
in Northern Italy (Giuffrida et al., 2013). These pungency values are sub-
stantially lower than the value found in the present study, 177 000 ± 700
Shu for the Fatali and 120 000 ± 32 000 Shu for the Tabasco cultivar, respec-
tively. In the non-peer-reviewed literature substantially different values of
the pungency can be found. E.g., a book written by an experienced grower
(Tvedegaard, 2104) quotes a value of approximately 500 000 Shu for the Fa-
tali cultivar and 100 000 Shu for the Tabasco cultivar. Also Liu et al. (2013)
gives a pungency for the Tabasco cultivar of 30 000 to 120 000 Shu. These
values are much closer to those found in the present work. There are many
different factors that can influence the pungency; e.g., maturity of the fruits
is known to substantially influence the pungency (Iwai et al., 1979). More
measurements of samples from different growers and of different geographi-
cal origin are needed in order to determine the typical pungency of both the
Fatali and the Tabasco cultivar.

It is often assumed that the major capsaicinoids Cap and DHCP make
up to about 80 % to 90 % of the total contents of capsaicinoids (Wahyuni
et al., 2013; Eich, 2008). In the present study we find that they in some
case, e.g., for Esppelte or Hot Banana chillies, only make up around 60 %. This emphasises the need to measure all capsaicinoids when determining the
pungency of chillies.

In conclusion, we have in the present work expanded the data base for
quantitative reliable values of the contents of capsaicinoids for several new
chilli cultivars and furthermore shown that the pungency of chillies grown in
Denmark is in the same range as found for chillies grown in other and warmer
geographical areas. This new data will provide a solid and quantitative basis
for choosing the best suited cultivars for growing chillies with a specified pungency in Denmark and in other areas with similar climatical conditions.

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Literature


