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1 **Title:**

2 **Effects of a n-3 polyunsaturated fatty acid enriched diet on embryo production in dairy cows**

3

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15

16 **Short Title: n-3 PUFA improved embryo production**

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19 and figure legends.

20

Abstract (250 words)

Beneficial effects of n-3 polyunsaturated fatty acid (PUFA) supplementation on dairy cow reproduction have been previously reported. The objectives of the present study were to assess whether n-3 PUFA supplementation would affect *in vitro* embryo production (IVP) after ovarian stimulation. Holstein cows received a diet with 1% dry matter supplementation of either n-3 PUFA ($n = 18$, micro encapsulated fish oil) or a control, n-6 PUFA ($n = 19$, micro encapsulated soy oil). Both plasma and follicular fluid FA composition showed integration of total PUFA through the diet. All cows underwent an IVP protocol consisting of ovarian stimulation, ultrasound-guided transvaginal oocyte retrieval (ovum pick-up, OPU, 5 per cow) followed by *in vitro* maturation, fertilisation and 7 days of embryo development. A tendency toward an increase in the blastocyst rate (diet effect, $p = 0.0865$) was observed in n-3 cows, with $49.6 \pm 5.5\%$, versus $42.3 \pm 5.5\%$ in control n-6 cows. A significant increase (diet effect, $p = 0.0217$) in the good quality blastocyst rate (freezable blastocysts) was reported in n-3 cows ($42.2 \pm 7.7\%$) compared to control n-6 cows ($32.7 \pm 7.7\%$). A significant difference in lipid composition was shown in the oocytes recovered by OPU from n-3 and n-6 treated cows, by intact single-oocyte MALDI-TOF mass spectrometry. The 42 differentially abundant identified lipids were mainly involved in cell membrane structure. In conclusion, n-3 PUFA supplementation enhanced oocyte quality and modified their lipid composition. Further studies are necessary to investigate the potential link of these lipid modifications with enhanced oocyte quality.

42 Introduction

43 Reproductive performance in cows is influenced by nutritional and metabolic status, as previously
44 reviewed (Butler, 2000, Roche, 2006, Leroy et al., 2008). Appropriate plasma fatty acids (FA) and
45 polyunsaturated FA (PUFA) composition affects various reproductive processes, including steroid
46 hormones and prostaglandin precursor syntheses via cholesterol and arachidonic acid, respectively (Urlep
47 et al., 2013, Tessaro et al., 2015). Previous studies reported beneficial effects of n-3 PUFA supplementation
48 on dairy cow reproduction (reviewed in (Moallem, 2018)). The n-3 PUFA belong to a family of biologically
49 active essential FA. Given the poor conversion rate between the n-3 PUFA short chain alpha-linolenic acid
50 (ALA, C18:3), and the long chain n-3 PUFA (LC n-3 PUFA), eicosapentaenoic acid (EPA, C20:5) and
51 docosahexaenoic acid (DHA, C22:6), these LC n-3 PUFA need to be provided directly through the diet in
52 order to increase their abundance in the plasma (Simopoulos, 2002, Plourde et al., 2007, Calder, 2012).
53 EPA and DHA are mainly found in fish oil, as well as in microalgae oil (Abughazaleh et al., 2009).

54 The n-3 PUFA have beneficial effects on cow reproduction, in several ways. Indeed, cows being
55 fed a flaxseed diet had a higher pregnancy rate in relation to a decrease in embryo mortality (Petit et al.,
56 2006), as well as an increase in the size of pre-ovulatory (Ambrose et al., 2006) and small follicles (Zachut
57 et al., 2010). Conception rates also tended to be higher in cows receiving an ALA-enriched diet (Ambrose
58 et al., 2006, Dirandeh et al., 2013) or a LC n-3 PUFA diet (Sinedino et al., 2017, Elis et al., 2016b). One
59 reported mechanism leading to increased conception rates was the uterine effect of n-3 PUFA reducing
60 prostaglandin F2 alpha (PGF2 α) and, therefore, reducing embryo mortality (Mattos et al., 2004).
61 Nevertheless, other studies suggested a direct beneficial ovarian effect of LC n-3 PUFA. Indeed, *in vitro*
62 embryo production, performed after ultrasound-guided transvaginal oocyte retrieval (ovum pick-up)
63 without ovarian stimulation treatment, was enhanced after n-3 PUFA supplementation compared to the
64 control, consisting of a saturated FA supplementation (Moallem et al., 2013). Moreover, *in vitro* studies
65 also reported that *in vitro* maturation (IVM) medium supplemented with either ALA (Marei et al., 2009) or
66 low dose DHA (Oseikria et al., 2016) led to increased embryo developmental rates. Since previous studies
67 also reported that n-6 PUFA could lead to beneficial effects on reproduction (reviewed in (Leroy et al.,
68 2014)), it is therefore important to compare n-3 PUFA supplementation to a n-6 control, in order to prove a

69 specific n-3 PUFA effect. Indeed, when comparing n-3 PUFA to a saturated control, any beneficial effect
70 could be due to the difference between saturated and polyunsaturated FA, which is not specific to n-3
71 PUFA.

72 The present study relies on the hypothesis that n-3 PUFA supplementation of the diet of donor cows
73 could improve embryo production both in terms of number and quality of embryos after ovarian stimulation.
74 The objectives of the present study in dairy cows were therefore 1) to assess whether dietary
75 supplementation with LC n-3 PUFA (in comparison with a n-6 PUFA control diet) would affect *in vitro*
76 embryo production, performed after ovarian stimulation by gonadotrophins (FSH treatment), thus
77 mimicking usual *in vitro* or *in vivo* embryo production conditions; 2) to assess several LC n-3 PUFA
78 supplementation durations in order to determine whether a short duration could be long enough to observe
79 beneficial effects of the diet on embryo production; and 3) to analyse oocyte lipid composition after LC n-
80 3 PUFA diet supplementation.

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82 **Materials and methods**

83 **Experimental design**

84 All experimental protocols were conducted in accordance with the European Directive 2010/63/EU
85 on the protection of animals used for scientific purposes and approved by the French Ministry of National
86 Education, Higher Education, Research and Innovation after ethical assessment by the local ethics
87 committee “Comité d’Ethique en Expérimentation Animale Val de Loire (CEEVA VdL)” (protocol
88 registered under ref. APAFIS#2098-2015100115278976_v5).

89 Holstein primiparous cows ($n = 37$) were managed in loose housing during lactation. In order to
90 conclude that the observed effects were specifically due to n-3 PUFA, cows supplemented with n-6 PUFA
91 were used as a control group. Each cow received either n-3 ($n = 18$) or n-6 ($n = 19$) supplementation for 9
92 weeks, starting at ≈ 11 weeks postpartum. All cows underwent five sessions of OPU. Three of these OPU
93 sessions, occurring after ovarian stimulation (FSH treatment), led to *in vitro* embryo production, after 2, 5
94 and 7 weeks of supplementation. The two other OPU sessions led to oocyte collection and lipidomic
95 analyses, after 3 weeks (without ovarian stimulation) and 9 weeks (with ovarian stimulation) of
96 supplementation (Figure 1).

98 **Experimental diets and dry matter intake**

99 For 9 weeks, dairy cows received a diet consisting of (% of total diet dry matter, DM): 59.4% corn
100 silage, 14.5% Sandilait® (soybean and rapeseed meal; Agralys, Blois, France), 9.5% Sandifort® (wheat;
101 Agralys, Blois, France), 8.5% alfalfa hay, 7.5% dehydrated alfalfa, 0.2% vitamins and minerals 5/23, 0.4%
102 calcium bicarbonate. The n-3 PUFA supplement was OMG750®, a microencapsulated fish oil (Kemin,
103 Nantes, France) and the n-6 PUFA supplement was OMGSOY®, a microencapsulated soy oil (Kemin,
104 Nantes, France), with both supplements being distributed at 1% DM. The two diets were total mixed rations
105 (TMR), with feed values calculated using the INRA French feeding system (INRA, 2018). The supplements
106 were manually mixed into the diet and the TMR were distributed twice daily in individual weighing troughs
107 (Insentec B.V., Marknesse, The Netherlands), as described by (Elis et al., 2016b). Cows were fed *ad libitum*

108 and DM intake (DMI) was determined from the feed intake, the composition of the diets and the dry matter
109 content of each ingredient included in the diets. The nutritional values of the different ingredient
110 compositions in the diets were calculated from a chemical analysis. DMI was analysed daily during the
111 distribution of the n-3 or n-6 diets, throughout the supplementation period.

113 **Body weight, milk yield and energy balance**

114 Body weight (BW) and milk yield (MY) were monitored daily during the supplementation period.
115 All cows were milked twice daily. In the milking parlor, the MY (kg/d) of each cow was automatically
116 recorded (software Manufeed 500 pro, vc5 version 2.011.14). After each milking period, cows were
117 automatically weighed (software RIC version RW1.7). Only the BW recorded in the morning was used for
118 statistical analysis.

119 Energy balance (EB, expressed in Mcal/d) was calculated during the supplementation period and
120 corresponds to the difference between net energy intake and net energy needs for body maintenance and
121 lactation, according to the INRA method (INRA, 2018).

123 **AMH and metabolic assays, fatty acid composition of plasma and follicular fluid**

124 Plasma Anti Müllerian Hormone (AMH) was determined using the AMH Gen II ELISA assay
125 (Beckman Coulter, Villepinte, France) using 50 μ L of undiluted plasma, as previously described (Rico et
126 al., 2009), from samples collected the first day of the diet supplementation and stored at -20 °C. AMH, an
127 indicator of the ovarian response after hormonal stimulation, was assessed for any differences in plasma
128 AMH between the groups.

129 For metabolic assays, plasma samples were collected once per week from caudal venipuncture
130 before feeding, during the supplementation period. Plasma samples were stored at -20 °C until the assays
131 were conducted. Plasma NEFA, urea and glucose were determined using enzymatic colorimetry with a
132 multi-parameter analyser (KONE Instruments Corporation, Espoo, Finland).

133 Plasma and follicular fluid fatty acid compositions were determined using gas chromatography, as
134 previously described (Lefils et al., 2010). Plasma fatty acid composition was determined at the beginning
135 of the supplementation period and in samples corresponding to OPU leading to *in vitro* embryo production
136 (at 2, 5 and 7 weeks postpartum, Figure 1). Follicular fluid fatty acid composition was determined at 2, 5
137 and 7 weeks postpartum.

138 **Embryo production**

139 **Oestrus synchronisation and ovarian stimulation**

140 Eleven days prior to supplementation (=d0, Figure 1), each cow received a synchronisation
141 treatment consisting of a 3.3 mg norgestomet subcutaneous implant and an intra muscular (IM) injection of
142 0.001 mg buserelin (Crestar Pack®, MSD Santé Animale, Beaucouzé, France). Seven days later, each cow
143 received an IM injection of 15 mg luprostriol (Prosolvlin®, Virbac, Carros, France) and 2 days later, the
144 subcutaneous implant was removed. Oestrus was observed ≈48 h following implant removal, which
145 corresponded to the first day of supplementation, and a new subcutaneous implant of 3.3 mg norgestomet
146 was inserted this same day (Crestar® SO, MSD Santé Animale, Beaucouzé, France). The norgestomet
147 implant was then replaced every 10 days during the 9 weeks of the experiment, until the end of the protocol,
148 to prevent the occurrence of oestrus between OPU sessions.

149 Ovarian stimulation was performed using 400 µg of pFSH per cow (Stimufol®, Reprobiol, Ouffet,
150 Belgium) divided into five IM injections of decreasing FSH doses (112, 100, 75, 63 and 50 µg) every 12 h,
151 beginning 60 h prior to the follicular punctures.

152 **Ovum pick-up**

153 The ultrasound-guided transvaginal oocyte retrieval (ovum pick-up) was performed under locoregional
154 anaesthesia (epidural block) with 86.5 to 173 mg of procaine per cow (Procamidol®, Richter Pharma, Wels,
155 Austria), after sedation with 10 mg/100 kg xylazine (Rompun®, Bayer Animal Health, Saint-Georges-de-
156 Reneins, France). The anogenital area was then washed and disinfected (Vétédine savon®, Vétoquinol,

157 Lure, France). A guide containing an ultrasonographic probe was inserted via the vaginal route and the
158 ovary was positioned by the technician through the transrectal route against the probe (probe EC123,
159 7.5 MHz, echograph MyLab30, ESAOTE Pie Medical, Saint-Germain-en-Laye, France). A needle holder,
160 including a needle (18 G) and linked to a suction system, was introduced via the transvaginal route. The 37
161 cows were divided into five groups of 6 to 9 cows. For each group, one OPU session occurred on the same
162 day. The complete experimental design (groups 1 to 5) was performed over a 14-month period.

163 ***In vitro* embryo production**

164 Complexes oocyte-cumulus (COC) recovered from OPU sessions, performed after 2, 5 and 7 weeks
165 of supplementation, were selected and underwent *in vitro* maturation (IVM) followed by fertilisation (IVF).
166 All straws of semen used to performed the IVF were produced from a single ejaculate of a single Holstein
167 bull. The produced zygotes then underwent *in vitro* development (IVD), according, according to a
168 previously described protocol (Elis et al., 2017, Oseikria et al., 2016). Quality of the produced embryos
169 was assessed through the cleavage rate at 48 h (reported to COC in IVM) and the blastocyst rate (reported
170 to cleaved embryos) at 7 days following IVF. Blastocyst quality was also graded, with grades ranging from
171 quality 1 (Q1) to quality 4 (Q4) blastocysts, according to the IETS (International Embryo Technology
172 Society) morphological criteria (International Embryo Transfer, 2013). Q1 and Q2 blastocysts were
173 considered as good quality and freezable blastocysts. All embryos have been graded by the same lab
174 technician.

175 **Oocyte lipidomic analyses**

176 Immature oocytes recovered from OPU sessions performed after 3 and 9 weeks of supplementation, in 9
177 (from the 18) n-3 cows and 9 (from the 19) n-6 cows, were used for lipidomic analyses: a total of 60 n-3
178 oocytes and 61 n-6 oocytes were compared.

179 Immature oocytes were completely mechanically denuded from Cumulus cells (CC) by repeated pipetting
180 and individually snap-frozen in drops of 20 mM Tris-HCl pH 6.8/260 mM sucrose buffer. Lipid profiles of
181 individual oocytes were obtained using an UltrafleXtreme MALDI-mass spectrometer in positive reflector

mode using 2,5-dihydroxyacetophenone matrix, as described (Elis et al., 2017). M/z peaks were detected in the range of 400 to 1000 m/z and values of the normalised peak heights (NPH) were quantified using Progenesis MALDI™ (Nonlinear Dynamics). Lipids were identified by high-resolution mass spectrometry by LC-MS or by direct infusion combined with top-down MS/MS analyses (Bertevello et al., 2018).

Statistical analyses

Statistical analyses were performed using SAS® software (SAS institute Inc., 2013), unless otherwise indicated. The stages (days in milk) and plasma AMH levels of n-3 and n-6 cows at the beginning of supplementation were compared using a Wilcoxon test (NPAR1WAY procedure). Linear mixed models (MIXED procedure) including the effects of diet, week of supplementation (= rank of OPU session), diet x week of supplementation interaction, with week of supplementation as a repeated effect within cow (repeated statement of the MIXED procedure, an AR(1) covariance structure was used for all parameters except for plasma and follicular fluid FA composition for which a CS covariance structure was used), and a random group effect were used for the following parameters: BW (with BW at 1 week of supplementation as a covariate), MY (with the day in milk corresponding to the first day of supplementation as a covariate), DMI (with BW as a covariate), EB, plasma NEFA, glucose, urea (with, for each of these three parameters, the plasma level measured on the first day of supplementation as a covariate), plasma and follicular fluid FA composition, number of COC recovered and that underwent IVM, number of embryos produced per OPU session. Logistic regression mixed models (GLIMMIX procedure) including the effects of diet, week of supplementation (= rank of OPU session), diet x week of supplementation interaction, and a random group effect were used for the following parameters: cleavage rates and embryo development rates. Results are presented as least squares means (lsmeans) ± SEM, unless otherwise indicated. Multiple comparisons of lsmeans estimated by the models were performed with a T-test, and a Bonferroni adjustment was used for all parameters except COC and embryo production parameters, plasma and follicular fluid FA composition parameters.

206 Relative lipid abundance in individual oocytes were compared using a T-test with a Benjamini–Hochberg
207 correction applied to the NPH values of each lipid species; multivariate principal component analysis (PCA)
208 was performed using differential NPH values (XLSTAT, Addinsoft, Paris, France).
209 Effects with $p \leq 0.05$ were considered significant, and effects with $0.05 < p \leq 0.1$ were considered
210 tendencies.

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211 Results

212 Physiological measurements

213 Supplementation began at 11.2 ± 0.3 weeks after calving, with no difference between the control n-6 and
214 n-3 groups ($p = 0.9273$). No difference was reported between n-3 and n-6 groups for BW, MY, DMI or EB
215 (Figure 2). During the 9-week supplementation period and the previous 8 weeks, BW averaged 572.3 ± 3.4
216 kg in n-3 cows *versus* 573.5 ± 3.3 kg in n-6 cows (diet effect, $p = 0.7421$). MY averaged 28.5 ± 1.5 kg/d in
217 n-3 cows *versus* 28.8 ± 1.5 kg/d in n-6 cows (diet effect, $p = 0.8069$). During the 9-week supplementation
218 period, DMI averaged 19.2 ± 1.0 kg/d in n-3 cows compared to 19.4 ± 1.0 kg/d in n-6 cows (diet effect, p
219 $= 0.8912$). EB was, on average, 0.6 ± 1.1 Mcal/d in n-3 cows *versus* 1.2 ± 1.1 Mcal/d in n-6 cows (diet
220 effect, $p = 0.6192$). For these four measurements, the effect of week of supplementation was significant (p
221 ≤ 0.05), without an interaction between diet and week of supplementation.

223 Metabolic measurements

224 Metabolic measurements, measured in plasma (NEFA, glucose, urea), did not differ between n-3 cows and
225 control n-6 cows during the 9-week supplementation period (Figure 3). Indeed, n-3 cows exhibited a plasma
226 NEFA level of 0.30 ± 0.02 mM compared to 0.32 ± 0.02 mM in the control n-6 cows (diet effect, $p =$
227 0.2911). The plasma glucose levels were, on average, 4.18 ± 0.05 mM in n-3 cows *versus* 4.13 ± 0.05 mM
228 in control n-6 cows (diet effect, $p = 0.4925$). The plasma urea levels were not different (diet effect, $p =$
229 0.1834) between n-3 cows (4.23 ± 0.17 mM) and control n-6 cows (4.40 ± 0.17 mM). For these three
230 measurements, the effect of the week of supplementation was significant ($p \leq 0.05$), without an interaction
231 between diet and week of supplementation, except for urea level, which had a significant effect of the
232 interaction between diet and week of supplementation ($p = 0.025$).

234 Plasma and follicular fluid fatty acid composition

235 The fatty acid composition, expressed in % of total fatty acids, was measured in plasma, to assess the
236 efficiency of the PUFA supplementation (Table 1), and in follicular fluid, to study how PUFA nutritional

237 changes affect the fatty acid composition of this ovarian compartment (Table 2). Half of the measurements
238 in plasma (15/27) and follicular fluid (10/27) varied throughout the period of supplementation (week of
239 supplementation effect, $p \leq 0.05$). In n-3 cows, after only 2 weeks of supplementation, a significant 2-fold
240 increase was observed in plasma EPA, compared to the period before supplementation ($p < 0.0001$).
241 Similarly, a significant 2.1-fold increase ($p < 0.0001$) and 1.2-fold increase ($p < 0.0001$) were also observed
242 for DHA and total n-3 PUFA, respectively, compared to the period before supplementation. The week of
243 supplementation effect was $p < 0.0001$ for EPA, $p < 0.0001$ for DHA and $p = 0.0033$ for total n-3 PUFA;
244 these increases validated the efficiency of the n-3 diet. Concerning EPA and total n-3 PUFA, an effect of
245 the diet was reported ($p < 0.0001$): plasma level at 2 weeks of supplementation was significantly increased
246 for EPA (1.7-fold, $p < 0.0001$) and total n-3 PUFA (1.2-fold, $p = 0.0002$) in n-3 cows compared to n-6
247 cows; plasma level at 7 weeks of supplementation was significantly increased for DHA (1.6-fold, $p =$
248 0.0298), this increase being a tendency at 5 weeks of supplementation (1.5-fold, $p = 0.0534$), in n-3 cows.
249 Moreover, the follicular fluid level also increased by 1.3-fold for EPA after 2 weeks of supplementation (p
250 $= 0.0344$) and for total n-3 PUFA after 5 weeks of supplementation ($p < 0.0001$) in n-3 cows compared to
251 control n-6 cows. Concerning total n-6 PUFA (diet effect, $p = 0.0081$), a tendency toward a 1.1-fold increase
252 was reported in control n-6 cow plasma at 2 weeks of supplementation ($p = 0.0833$), with this 1.1-fold
253 increase becoming significant at 5 weeks of supplementation ($p = 0.0039$). In n-3 cows, the n-6 PUFA/n-3
254 PUFA ratio (diet effect, $p = 0.0010$) was 1.3-fold lower in n-3 cow plasma at 2 weeks of supplementation
255 ($p = 0.0075$) and 1.6-fold lower in n-3 cow follicular fluid at 7 weeks of supplementation ($p = 0.0052$),
256 compared to control n-6 cows. For these five measurements (EPA, DHA, total n-3 PUFA, total n-6 PUFA
257 and n-6/n-3 ratio), the diet x week of supplementation interaction was significant ($0.0001 < p \leq 0.0012$).

259 Embryo production

260 Three embryo production sessions by OPU-IVF were performed for 18 n-3 cows and 19 control n-6 cows,
261 generating 54 and 57 OPU-IVF sessions and a total of 1462 and 1538 punctured follicles, respectively
262 (Table 3). Plasma AMH level was not different between the groups ($p = 0.4941$), suggesting an absence of

263 a difference in the ovarian response to hormonal stimulation between the groups; it was, on average, 299.0
264 ± 73.4 pg/mL in n-3 cows compared to 242.3 ± 55.6 pg/mL in control n-6 cows. The average number of
265 punctured follicles per OPU session did not differ (diet effect, $p = 0.8196$) between n-3 cows (26.7 ± 4.3)
266 and control n-6 cows (26.1 ± 4.3).

267 A significantly higher recovered COC rate (diet effect, $p = 0.0035$) was observed in n-3 cows (38.0
268 $\pm 1.6\%$) compared to control n-6 cows ($32.8 \pm 1.6\%$). This rate corresponded to 10.2 ± 1.3 oocytes
269 recovered per OPU session in n-3 cows compared to 8.5 ± 1.3 from control n-6 cows (diet effect, $p =$
270 0.2297). The cleavage rate tended to be lower ($p = 0.1033$) in n-3 cows ($77.3 \pm 3.8\%$) compared to control
271 n-6 cows ($82.3 \pm 3.3\%$), which corresponded to 5.8 ± 1.0 cleaved embryos in n-3 cows *versus* 5.0 ± 1.0 in
272 control n-6 cows (diet effect, $p = 0.3597$). The blastocyst rate tended to be higher (diet effect, $p = 0.0865$)
273 in n-3 cows ($49.6 \pm 5.5\%$), *versus* control n-6 cows ($42.3 \pm 5.5\%$), corresponding to 2.8 ± 0.6 blastocysts
274 per OPU session in n-3 cows *versus* 2.2 ± 0.6 blastocysts in control n-6 cows (diet effect, $p = 0.2136$). This
275 tendency was observed only during the first OPU session ($p = 0.1024$), therefore, only after 2 weeks of
276 supplementation. The quality of blastocysts was also morphologically graded, into good quality embryos
277 (Q1 and Q2 according to the IETS classification, considered as freezable embryos) and lower quality
278 embryos (Q3 and Q4). A significant increase (diet effect, $p = 0.0217$) in the Q1-Q2 blastocyst rate was
279 noted in n-3 cows ($42.2 \pm 7.7\%$) compared to control n-6 cows ($32.7 \pm 7.7\%$), which corresponded to 2.5
280 ± 0.5 Q1-Q2 blastocysts in n-3 cows *versus* 1.8 ± 0.5 Q1-Q2 blastocysts in control n-6 cows (diet effect, p
281 $= 0.1527$). This difference was significant after 5 weeks of supplementation ($p = 0.0447$) and a trend after
282 2 weeks of supplementation ($p = 0.0773$). No difference was observed after 7 weeks of supplementation
283 between the diet groups, for any parameter. Indeed, in n-3 cows, embryo development rates were
284 maintained at the same levels as for the previous OPU-IVF session (after 2 and 5 weeks of dietary
285 supplementation), but were no longer different from the developmental rates of control n-6 cows.
286 Concerning embryo development rates, no parameter showed neither a significant week of supplementation
287 effect, except for the recovered COC rate ($p = 0.0054$), nor a significant diet x week of supplementation
288 interaction. Concerning the number of embryos produced per OPU session, no parameter showed a
289 significant week of supplementation effect or a significant diet x week of supplementation interaction.

Oocyte lipid composition

A total of 60 single-oocytes from 9 n-3 cows (n-3 oocytes) and 61 oocytes from 9 n-6 cows (n-6 oocytes) were analysed by intact cell MALDI-TOF mass spectrometry, to compare their lipid composition. Physiological and metabolic measurements for these two subgroups (9 n-3 and 9 n-6 cows) were representative of the whole groups (respectively 18 n-3 and 19 n-6 cows) (Supplementary Figure 1 and Supplementary Tables 1 and 2). Hierarchical clustering was performed, based on 110 m/z that were differentially abundant between n-3 and n-6 oocytes ($p < 0.05$, > 2 -fold change, Figure 4A). A heatmap represents the relative abundance of 55 up-regulated and 55 down-regulated m/z in the n-3 group as compared to the n-6 group (Figure 4A and Supplementary Table 3); each line corresponds to one oocyte and each column corresponds to one differential molecular species. Two clear clusters were distinguished, corresponding to over-abundant lipids in either n-3 or n-6 oocytes. A principle component analysis performed on differential m/z clearly discriminated n-3 oocytes and control n-6 oocytes, based on their lipid composition (Figure 4B). Among these 110 differential m/z, 42 lipid species were identified (Supplementary Table 4). Among them, 12 phosphatidylcholines (PC), three phosphatidylethanolamines (PE, C36), two sphingomyelins (SM, C35) and lyso-phosphatidylcholine LPC 22:4 were more abundant in n-3 oocytes, whereas 15 PC, PE 30:0, SM 34:1, two LPC (16:0 and 18:0) and two triacylglycerols (46:1, 47:1) were more abundant in n-6 oocytes.

Discussion

This present work is the first, to our knowledge, to assess whether the effects of a n-3 diet on *in vitro* embryo production in dairy cows still occurred after ovarian stimulation, compared to control cows supplemented with a n-6 diet; it was also the first to assess the effects of several supplementation durations. The results suggest that n-3 supplementation could enhance embryo quality, even with a relatively short supplementation duration of 2 to 5 weeks.

Supplementation of the diet with n-3 PUFA led to an increase in the Q1-Q2 blastocyst rate, even when compared to control cows supplemented with n-6 PUFA, and even after ovarian stimulation. Such

317 supplementation could therefore be a benefit to the *in vitro* embryo production field. This increase in good
318 quality embryos is consistent with previous studies reporting a positive effect of n-3 supplementation on
319 conception or gestation rates (for a review, (Moallem, 2018). Indeed, n-3 supplementation seemed to
320 enhance gestation rate (Ambrose et al., 2006, Petit et al., 2006, Dirandeh et al., 2013, Sinedino et al., 2017),
321 partly through enhancing embryo implantation (Mattos et al., 2003), but also by affecting oocyte quality
322 (Elis et al., 2016b, Moallem et al., 2013). Moreover, other studies were performed on embryo production,
323 without ovarian stimulation treatment. An increase in the cleavage rate was reported after flaxseed (Zachut
324 et al., 2010) and fish oil supplementation (Moallem et al., 2013). These results were also consistent with *in*
325 *vitro* studies in which a supplementation of the IVM medium with n-3 PUFA, therefore over only 24 h, also
326 led to an enhancement of the metaphase2 oocyte rate and the subsequent cleavage and blastocyst rates (Elis
327 et al., 2017, Oseikria et al., 2016, Marei et al., 2009). In the future, it would be interesting to assess whether
328 coupling the supplementation of the diet of oocyte donor cows and of IVM medium with n-3 PUFA could
329 further improve *in vitro* embryo production.

330 The increases in blastocyst rates reported in the present study were only moderate, but these results
331 are nonetheless interesting, and consistent with another study also performed after ovarian stimulation
332 (Thangavelu et al., 2007). In such conditions, one could expect a loss of this effect, due to the strong ovarian
333 stimulation effect of hormonal treatment. The observation of such an effect of n-3 supplementation is thus
334 an interesting result that is encouraging for its use in embryo production or for the improvement of the
335 fertility of dairy cows. Moreover, the control used in the present study was n-6 supplementation, which is
336 the optimal control to evaluate a specific effect of n-3 PUFA. Indeed, when comparing the effect of n-3
337 PUFA to a saturated FA control, any reported difference could be due to the fact that a saturated FA is
338 being compared to a PUFA, but it would not be possible to prove that it is due to the specific effect of n-3
339 PUFA. On the other hand, the n-6 PUFA control exhibited similar effects as n-3 PUFA (Leroy et al., 2014);
340 it is therefore more difficult to prove a significant difference between the n-6 and n-3 groups of cows.
341 Previous studies (cited above) reported that cleavage rates increase in n-3 PUFA groups compared to
342 saturated controls (Zachut et al., 2010, Moallem et al., 2013), but they also reported an absence of a
343 difference when compared to a n-6 PUFA group (Zachut et al., 2010). Moreover, another study reported a

344 difference in the number of blastomeres of transferable embryo after PUFA supplementation compared to
345 saturated supplementation, but it was not possible to highlight such difference between n-3 and n-6
346 supplementation group (Thangavelu et al., 2007).

347 In the present study, no difference in the number of punctured follicles was shown. This was
348 expected because, even if n-3 PUFA supplementation has been reported to increase follicular population
349 (Petit et al., 2002, Bilby et al., 2006, Zachut et al., 2010), this same effect is also observed with n-6 PUFA
350 supplementation (for a review, (Leroy et al., 2014). Moreover, none of the embryo production parameters
351 measured at the fourth OPU (after 7 weeks of supplementation) were different between n-3 PUFA and n-6
352 PUFA cows. Indeed, after 7 weeks of supplementation, a significant increase in plasma n-6 PUFA was
353 reported in the FA composition of the control n-6 compared to the n-3 PUFA cows. This increase might
354 suggest that the beneficial effects of n-6 PUFA on embryo production could explain why control n-6 PUFA
355 embryo rates matched the embryo rates of the n-3 PUFA group, rendering it impossible to find a difference
356 between the groups. Even though the addition of a third experimental group of cows (consisting of a
357 saturated FA diet as a control) was not possible in our conditions, a comparison with this third group would
358 have highlighted the obtained results.

359 Concerning the duration of n-3 PUFA supplementation required to observe a beneficial effect, the
360 present study suggests, even if it has to be further confirmed, that a short duration of supplementation
361 (around 2 to 5 weeks) could be long enough to observe an improvement in embryo production. Indeed, in
362 our study, a longer period of supplementation did not lead to higher embryo rates. A short period of
363 supplementation means that such supplementation could be applied to the field of embryo production, by
364 limiting the cost of supplementation (3.6€/d/cow in average in our study). Moreover, *in vitro* results
365 suggested that improvement of blastocyst rates was especially observed in low quality oocytes (Elis et al.,
366 2017, Oseikria et al., 2016); it is therefore possible that such improvements would not be observed in high
367 quality oocytes. In addition, the positive effects on embryo rates have not always been reported, i.e. when
368 working with oocyte donor heifers rather than cows in lactation (Ponter et al., 2012). Discrepancies could
369 be attributed to differences in the amount or form of PUFA supplementation, but might also be attributed

370 to the quality of the recovered oocytes. Therefore, the type of supplementation would be especially
371 recommended when working with high genetic merit cows with unpredictable oocyte quality.

372 The increases in EPA, DHA and total n-3 PUFA percentages in plasma and/or follicular fluid fatty
373 acid composition allowed for the validation of the efficiency of such supplementation in dairy cows, which
374 is in line with our previous study (Elis et al., 2016b). The present study also showed that fatty acid
375 composition variations observed in the plasma were similar to variations observed in the follicular fluid,
376 which is consistent with the literature (Childs et al., 2008, Moallem et al., 2013). These variations needed
377 a longer period of supplementation to appear in follicular fluid compared to plasma, where they were
378 demonstrated after 2 weeks of supplementation.

379 To ensure that our results were not biased, we also studied physiological measurements. Indeed,
380 differences in MY or EB could contribute to differences in embryo quality. In our study, n-3 PUFA
381 supplementation was not associated with differences in BW, MY, DMI or EB nor with metabolic
382 differences in plasma NEFA, glucose or urea between the two groups of cows; this is consistent with our
383 previous data reporting the effect of this type of diet in dairy cows (Elis et al., 2016b). Indeed, the
384 supplementation was isoenergetic between n-3 and control n-6 groups, and moderate (1% DM), and we
385 therefore did not report the physiological variations that could be observed with supplementations at higher
386 doses or in a different form, such as a reduction in DMI and an increase in MY (Leroy et al., 2014). The
387 absence of metabolic differences, which are in line with previous studies for NEFA (Mattos et al., 2004,
388 Mashek et al., 2005) and plasma glucose (Ambrose et al., 2006) levels, are also probably due to the
389 moderate quantity (1% DM) distributed.

390 Finally, an increase in the recovered COC rate was reported in n-3 PUFA cows. Even if we have no
391 direct explanation for this finding, the high number of follicles punctured suggests that this difference is
392 real and asks the hypothesis of physical and structural changes between the COC of both groups. Indeed,
393 the lipidomic analyses of the oocytes showed changes mostly in phosphoglycerolipid compositions (mostly
394 PC, 12/18 up-regulated lipids and 15/24 down-regulated lipids in n-3 oocytes) and SM, with some lipids
395 being up-regulated and others being down-regulated in n-3 oocytes. PC lipids are a major component of the
396 cell membrane, and SM are involved in membrane structure stabilisation (Zheng et al., 2006), therefore,

397 these changes could potentially be linked to cell membrane composition, and could be also linked to
398 increased elasticity or suction resistance, allowing for an increased COC recovered rate (observed in n-3
399 group). Such changes in membrane composition were previously reported (Calder, 2015). Moreover, less
400 TG (mainly involved in energy storage) was reported in n-3 oocytes, which is consistent with previously
401 reported results suggesting that n-3 supplementation leads to increased lipolysis (Elis et al., 2016a). Further
402 studies are necessary to investigate the relationship between the specific lipids that present a change in their
403 composition and an enhanced oocyte quality.
404

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406 Declaration of interest

407 The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality
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420 References

- 421 ABUGHAZALEH, A. A., POTU, R. B. & IBRAHIM, S. 2009. Short communication: The effect of
422 substituting fish oil in dairy cow diets with docosahexaenoic acid-micro algae on milk
423 composition and fatty acids profile. *J Dairy Sci*, 92, 6156-9.
- 424 AMBROSE, D. J., KASTELIC, J. P., CORBETT, R., PITNEY, P. A., PETIT, H. V., SMALL, J. A. &
425 ZALKOVIC, P. 2006. Lower pregnancy losses in lactating dairy cows fed a diet enriched in
426 alpha-linolenic acid. *J Dairy Sci*, 89, 3066-74.
- 427 BERTEVELLO, P., TEIXEIRA-GOMES, A.-P., SEYER, A., VITORINO CARVALHO, A., LABAS,
428 V., BLACHE, M.-C., BANLIAT, C., CORDEIRO, L., DURANTHON, V., PAPILLIER, P., et al.
429 2018. Lipid Identification and Transcriptional Analysis of Controlling Enzymes in Bovine
430 Ovarian Follicle. *International Journal of Molecular Sciences*, 19, 3261.
- 431 BILBY, T. R., SOZZI, A., LOPEZ, M. M., SILVESTRE, F. T., EALY, A. D., STAPLES, C. R. &
432 THATCHER, W. W. 2006. Pregnancy, bovine somatotropin, and dietary n-3 fatty acids in
433 lactating dairy cows: I. Ovarian, conceptus, and growth hormone-insulin-like growth factor
434 system responses. *J Dairy Sci*, 89, 3360-74.
- 435 BUTLER, W. R. 2000. Nutritional interactions with reproductive performance in dairy cattle. *Anim*
436 *Reprod Sci*, 60-61, 449-57.
- 437 CALDER, P. C. 2012. Mechanisms of action of (n-3) fatty acids. *J Nutr*, 142, 592S-599S.

- CALDER, P. C. 2015. Marine omega-3 fatty acids and inflammatory processes: Effects, mechanisms and clinical relevance. *Biochim. et Biophys. Acta (BBA) - Molecular and Cell Biology of Lipids*, 1851, 469-484.
- CHILDS, S., HENNESSY, A. A., SREENAN, J. M., WATHES, D. C., CHENG, Z., STANTON, C., DISKIN, M. G. & KENNY, D. A. 2008. Effect of level of dietary n-3 polyunsaturated fatty acid supplementation on systemic and tissue fatty acid concentrations and on selected reproductive variables in cattle. *Theriogenology*, 70, 595-611.
- DIRANDEH, E., TOWHIDI, A., ZEINOALDINI, S., GANJKHANLOU, M., ANSARI PIRSARAEI, Z. & FOULADI-NASHTA, A. 2013. Effects of different polyunsaturated fatty acid supplementations during the postpartum periods of early lactating dairy cows on milk yield, metabolic responses, and reproductive performances. *Journal of Animal Science*, 91, 713-721.
- ELIS, S., DESMARCHAIS, A., FRERET, S., MAILLARD, V., LABAS, V., COGNIÉ, J., BRIANT, E., HIVELIN, C., DUPONT, J. & UZBEKOVA, S. 2016a. Effect of a long-chain n-3 polyunsaturated fatty acid-enriched diet on adipose tissue lipid profiles and gene expression in Holstein dairy cows. *Journal of Dairy Science*, 99, 10109-10127.
- ELIS, S., FRERET, S., DESMARCHAIS, A., MAILLARD, V., COGNIÉ, J., BRIANT, E., TOUZÉ, J.-L., DUPONT, M., FAVERDIN, P., CHAJÈS, V., et al. 2016b. Effect of a long chain n-3 PUFA-enriched diet on production and reproduction variables in Holstein dairy cows. *Animal Reproduction Science*, 164, 121-132.
- ELIS, S., OSEIKRIA, M., VITORINO CARVALHO, A., BERTEVELLO, P. S., CORBIN, E., TEIXEIRA-GOMES, A.-P., LECARDONNEL, J., ARCHILLA, C., DURANTHON, V., LABAS, V., et al. 2017. Docosahexaenoic acid mechanisms of action on the bovine oocyte-cumulus complex. *Journal of Ovarian Research*, 10, 74.
- INRA 2018. *Alimentation des ruminants: Apports nutritionnels - Besoins et réponses des animaux - Rationnement - Tables des valeurs des aliments*, Paris, France : Quae editions.
- INTERNATIONAL EMBRYO TRANSFER, S. 2013. *Manual of the International Embryo Transfer Society : a procedural guide and general information for the use of embryo transfer technology emphasizing sanitary procedures, 4th edition*, Champaign, Illinois, USA., Eds D.A Stringfellow & M. Daniel Givens.
- LEFILS, J., GÉLOËN, A., VIDAL, H., LAGARDE, M. & BERNOUD-HUBAC, N. 2010. Dietary DHA: time course of tissue uptake and effects on cytokine secretion in mice. *British Journal of Nutrition*, 104, 1304-1312.
- LEROY, J., STURMEY, R. G., VAN HOECK, V., DE BIE, J., MCKEEGAN, P. J. & BOLS, P. E. J. 2014. Dietary fat supplementation and the consequences for oocyte and embryo quality: hype or significant benefit for dairy cow reproduction? *Reproduction in Domestic Animals*, 49, 353-361.
- LEROY, J. L., VANHOLDER, T., VAN KNEGSEL, A. T., GARCIA-ISPIERTO, I. & BOLS, P. E. 2008. Nutrient prioritization in dairy cows early postpartum: mismatch between metabolism and fertility? *Reprod Domest Anim*, 43 Suppl 2, 96-103.
- MAREI, W. F., WATHES, D. C. & FOULADI-NASHTA, A. A. 2009. The effect of linolenic acid on bovine oocyte maturation and development. *Biol Reprod*, 81, 1064-72.
- MASHEK, D. G., BERTICS, S. J. & GRUMMER, R. R. 2005. Effects of intravenous triacylglycerol emulsions on hepatic metabolism and blood metabolites in fasted dairy cows. *J Dairy Sci*, 88, 100-9.
- MATTOS, R., GUZELOGLU, A., BADINGA, L., STAPLES, C. R. & THATCHER, W. W. 2003. Polyunsaturated fatty acids and bovine interferon-tau modify phorbol ester-induced secretion of prostaglandin F2 alpha and expression of prostaglandin endoperoxide synthase-2 and phospholipase-A2 in bovine endometrial cells. *Biol Reprod*, 69, 780-7.
- MATTOS, R., STAPLES, C. R., ARTECHE, A., WILTBANK, M. C., DIAZ, F. J., JENKINS, T. C. & THATCHER, W. W. 2004. The effects of feeding fish oil on uterine secretion of PGF2alpha, milk composition, and metabolic status of periparturient Holstein cows. *J Dairy Sci*, 87, 921-32.
- MOALLEM, U. 2018. Invited review: Roles of dietary n-3 fatty acids in performance, milk fat composition, and reproductive and immune systems in dairy cattle. *Journal of Dairy Science*.

- MOALLEM, U., SHAFRAN, A., ZACHUT, M., DEKEL, I., PORTNICK, Y. & ARIELI, A. 2013. Dietary alpha-linolenic acid from flaxseed oil improved folliculogenesis and IVF performance in dairy cows, similar to eicosapentaenoic and docosahexaenoic acids from fish oil. *Reproduction*, 146, 603-14.
- OSEIKRIA, M., ELIS, S., MAILLARD, V., CORBIN, E. & UZBEKOVA, S. 2016. N-3 polyunsaturated fatty acid DHA during IVM affected oocyte developmental competence in cattle. *Theriogenology*, 85, 1625-1634.
- PETIT, H. V., DEWHURST, R. J., SCOLLAN, N. D., PROULX, J. G., KHALID, M., HARESIGN, W., TWAGIRAMUNGU, H. & MANN, G. E. 2002. Milk production and composition, ovarian function, and prostaglandin secretion of dairy cows fed omega-3 fats. *J Dairy Sci*, 85, 889-99.
- PETIT, H. V. & TWAGIRAMUNGU, H. 2006. Conception rate and reproductive function of dairy cows fed different fat sources. *Theriogenology*, 66, 1316-24.
- PLOURDE, M. & CUNNANE, S. C. 2007. Extremely limited synthesis of long chain polyunsaturates in adults: implications for their dietary essentiality and use as supplements. *Appl Physiol Nutr Metab*, 32, 619-34.
- PONTER, A. A., GUYADER-JOLY, C., NUTTINCK, F., GRIMARD, B. & HUMBLLOT, P. 2012. Oocyte and embryo production and quality after OPU-IVF in dairy heifers given diets varying in their n-6/n-3 fatty acid ratio. *Theriogenology*, 78, 632-45.
- RICO, C., FABRE, S., MEDIGUE, C., DI CLEMENTE, N., CLEMENT, F., BONTOUX, M., TOUZE, J. L., DUPONT, M., BRIANT, E., REMY, B., et al. 2009. Anti-mullerian hormone is an endocrine marker of ovarian gonadotropin-responsive follicles and can help to predict superovulatory responses in the cow. *Biol Reprod*, 80, 50-9.
- ROCHE, J. F. 2006. The effect of nutritional management of the dairy cow on reproductive efficiency. *Anim Reprod Sci*, 96, 282-96.
- SAS INSTITUTE INC. 2013. *SAS/STAT 9.2 user's Guide, Second edition*. Cary, NC: SAS institute Inc.
- SIMOPOULOS, A. P. 2002. Omega-3 fatty acids in inflammation and autoimmune diseases. *J Am Coll Nutr*, 21, 495-505.
- SINEDINO, L. D. P., HONDA, P. M., SOUZA, L. R. L., LOCK, A. L., BOLAND, M. P., STAPLES, C. R., THATCHER, W. W. & SANTOS, J. E. P. 2017. Effects of supplementation with docosahexaenoic acid on reproduction of dairy cows. *Reproduction*, 153, 707-723.
- TESSARO, F. H., AYALA, T. S. & MARTINS, J. O. 2015. Lipid Mediators Are Critical in Resolving Inflammation: A Review of the Emerging Roles of Eicosanoids in Diabetes Mellitus. *Biomed Res Int*, 2015, 568408.
- THANGAVELU, G., COLAZO, M. G., AMBROSE, D. J., OBA, M., OKINE, E. K. & DYCK, M. K. 2007. Diets enriched in unsaturated fatty acids enhance early embryonic development in lactating Holstein cows. *Theriogenology*, 68, 949-57.
- URLEP, Z. & ROZMAN, D. 2013. The Interplay between Circadian System, Cholesterol Synthesis, and Steroidogenesis Affects Various Aspects of Female Reproduction. *Front Endocrinol (Lausanne)*, 4, 111.
- ZACHUT, M., DEKEL, I., LEHRER, H., ARIELI, A., ARAV, A., LIVSHITZ, L., YAKOBY, S. & MOALLEM, U. 2010. Effects of dietary fats differing in n-6:n-3 ratio fed to high-yielding dairy cows on fatty acid composition of ovarian compartments, follicular status, and oocyte quality. *Journal of Dairy Science*, 93, 529-545.
- ZHENG, W., KOLLMEYER, J., SYMOLON, H., MOMIN, A., MUNTER, E., WANG, E., KELLY, S., ALLEGOOD, J. C., LIU, Y., PENG, Q., et al. 2006. Ceramides and other bioactive sphingolipid backbones in health and disease: lipidomic analysis, metabolism and roles in membrane structure, dynamics, signaling and autophagy. *Biochim Biophys Acta*, 1758, 1864-84.

539 **Figure legends**

540

541 **Figure 1: Experimental design** – Thirty seven cows underwent five ovum pick-up (OPU)
542 sessions to either collect oocyte-cumulus complexes and perform *in vitro* embryo production
543 (OPU sessions 1, 3 and 4), or to collect oocytes and perform lipid composition mass
544 spectrometry analysis (OPU sessions 2 and 5). Cows received a diet supplemented with either
545 PUFA n-3 or PUFA n-6 supplementation during 9 weeks, beginning (=d0, d stands for day) on
546 average 11 weeks postpartum. Each cow received a synchronisation treatment, eleven days
547 prior to d0, consisting of a 3.3 mg norgestomet subcutaneous implant and an intra muscular
548 (IM) injection of 0.001 mg buserelin (Crestar Pack®, MSD Santé Animale, Beaucouzé,
549 France). Seven days later (d-4), each cow received an IM injection of 15 mg luprotriol
550 (Prosolvin®, Virbac, Carros, France) and 2 days later (d-2), the subcutaneous implant was
551 removed. Oestrus was observed \approx 48 h following implant removal (d=0), and a new
552 subcutaneous implant of 3.3 mg norgestomet was inserted on the same day (Crestar® SO, MSD
553 Santé Animale, Beaucouzé, France). The norgestomet implant was then replaced every 9 or 10
554 days until the end of the experiment (d64, last day of supplementation), to prevent the
555 occurrence of oestrus between OPU sessions. A FSH treatment (ovarian stimulation with
556 Stimufol® (Reprobiol, Ouffet, Belgium)was performed before OPU 1, OPU 3, OPU 4 and
557 OPU 5.

558

559 **Figure 2: Physiological measurements** – Body weight (A), milk yield (B), dry matter intake
560 (C) and energy balance (D) were monitored in 37 primiparous Holstein cows (n-3, $n = 18$; n-6,
561 $n = 19$). Cows received either a PUFA n-3 diet (black line) or a PUFA n-6 diet (gray line) for 9
562 weeks. Results are presented as lsmeans \pm SEM. * indicates a difference ($p < 0.05$); # indicates
563 a tendency ($p < 0.10$).

564

565 **Figure 3: Metabolic measurements** – Plasma NEFA (A), glucose (B) and urea (C) levels were
566 monitored once per week in 37 primiparous Holstein cows (n-3, $n = 18$; n-6, $n = 19$). Cows
567 received either a PUFA n-3 diet (black line) or a PUFA n-6 diet (gray line) for 9 weeks. Results
568 are presented as lsmeans \pm SEM. * indicates a difference ($p < 0.05$); # indicates a tendency (p
569 < 0.10).

570

571 **Figure 4: Oocyte lipid composition** – 60 oocytes and 61 oocytes, originating from 9 n-3 cows
572 and 9 n-6 cows, respectively, underwent individual lipid analysis by MALDI-TOF mass
573 spectrometry. (A) Hierarchical clustering representing the 110 m/z that exhibited a differential
574 abundance between n-3 and n-6 oocytes (higher abundance represented in green and lower
575 abundance in red). (B) Principle component analysis performed on n-3 and n-6 oocytes. (C)
576 Examples of identified lipids that were either up-regulated or down-regulated in n-3 oocytes.
577 LPC: lyso-phosphatidylcholine; SM: sphingomyelins; PC: phosphatidylcholines; PE:
578 phosphatidylethanolamines; TG: triacylglycerols.

579

580 **Supplementary Figure 1: Physiological and metabolic measurements** - Body weight, milk
581 yield, dry matter intake, energy balance (A) and plasma NEFA, glucose and urea levels (B)
582 were monitored during 9 weeks in 18 (from the 37) primiparous Holstein cows (n-3, $n = 9$; n-
583 6, $n = 9$) providing the oocytes analysed by mass spectrometry, for their lipid composition.
584 Cows received either a PUFA n-3 diet (black line) or a PUFA n-6 diet (gray line) for 9 weeks
585 of supplementation. Linear mixed models (MIXED procedure) included the effects of diet,
586 week of supplementation, diet x week of supplementation interaction and week of
587 supplementation as a repeated effect within cow (repeated statement of the MIXED procedure,
588 an AR(1) covariance structure was used for all parameters, except for plasma and follicular

589 fluid FA composition for which a CS covariance structure was used) were used for the
590 following parameters: BW (with BW at 1 week of supplementation as a covariate), MY (with
591 the day in milk corresponding to the first day of supplementation as a covariate), DMI (with
592 BW as a covariate), EB, plasma NEFA, glucose, urea (with, for each of these three parameters,
593 the plasma level measured the first day of supplementation as a covariate). Results are presented
594 as $lsm_{means} \pm SEM$. * indicates a difference ($p < 0.05$); # indicates a tendency ($p < 0.10$). No
595 diet effect was found for any measured parameter: BW ($p = 0.5765$), MY ($p = 0.9535$), DMI (p
596 $= 0.6089$), EB ($p = 0.5946$), NEFA ($p = 0.6206$), glucose ($p = 0.4728$) and urea ($p = 0.4339$).
597 A significant week of supplementation effect was found for all parameters, BW ($p < 0.0001$),
598 MY ($p < 0.0001$), DMI ($p = 0.0036$), NEFA ($p < 0.0001$) and glucose ($p = 0.0004$), except for
599 EB ($p = 0.2861$) and urea ($p = 0.9173$). No interaction between diet and week of
600 supplementation was reported for BW ($p = 0.4493$), MY ($p = 0.4474$), DMI ($p = 0.6284$), EB
601 ($p = 0.4318$), NEFA ($p = 0.0951$) and glucose ($p = 0.9527$). A significant interaction between
602 diet and week of supplementation was only reported for urea ($p = 0.0004$).

603

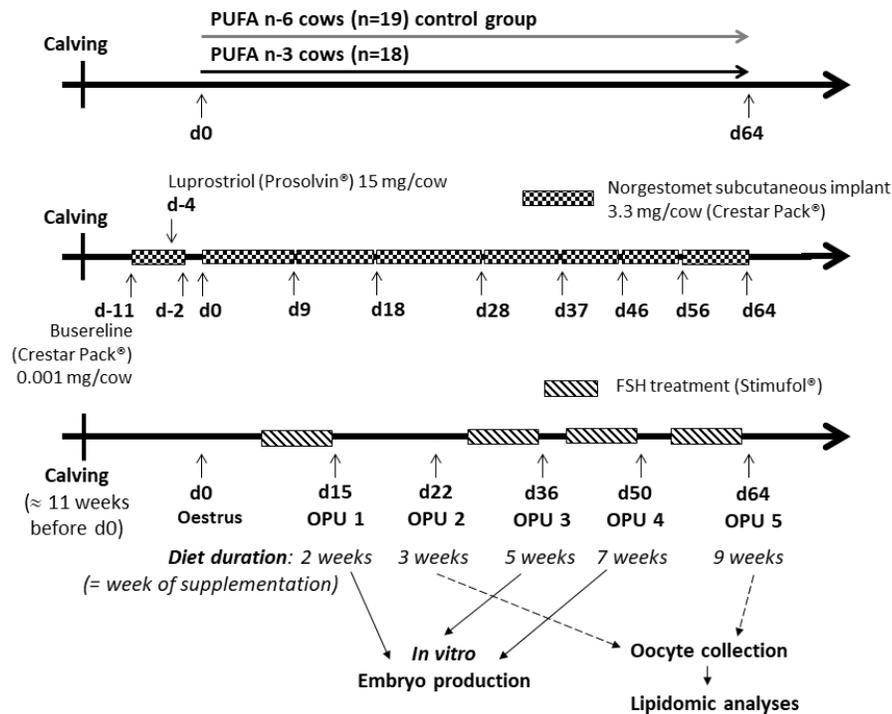


Figure 1: Experimental design – Thirty seven cows underwent five ovum pick-up (OPU) sessions to either collect oocyte-cumulus complexes and perform in vitro embryo production (OPU sessions 1, 3 and 4), or to collect oocytes and perform lipid composition mass spectrometry analysis (OPU sessions 2 and 5). Cows received a diet supplemented with either PUFA n-3 or PUFA n-6 supplementation during 9 weeks, beginning (=d0, d stands for day) on average 11 weeks postpartum. Each cow received a synchronisation treatment, eleven days prior to d0, consisting of a 3.3 mg norgestomet subcutaneous implant and an intra muscular (IM) injection of 0.001 mg buserelin (Crestar Pack®, MSD Santé Animale, Beaucozéz, France). Seven days later (d-4), each cow received an IM injection of 15 mg luprostriol (Prosolvlin®, Virbac, Carros, France) and 2 days later (d-2), the subcutaneous implant was removed. Oestrus was observed \square 48 h following implant removal (d=0), and a new subcutaneous implant of 3.3 mg norgestomet was inserted on the same day (Crestar® SO, MSD Santé Animale, Beaucozéz, France). The norgestomet implant was then replaced every 9 or 10 days until the end of the experiment (d64, last day of supplementation), to prevent the occurrence of oestrus between OPU sessions. A FSH treatment (ovarian stimulation with Stimufol® (Reprobiol, Ouffet, Belgium) was performed before OPU 1, OPU 3, OPU 4 and OPU 5.

254x190mm (96 x 96 DPI)

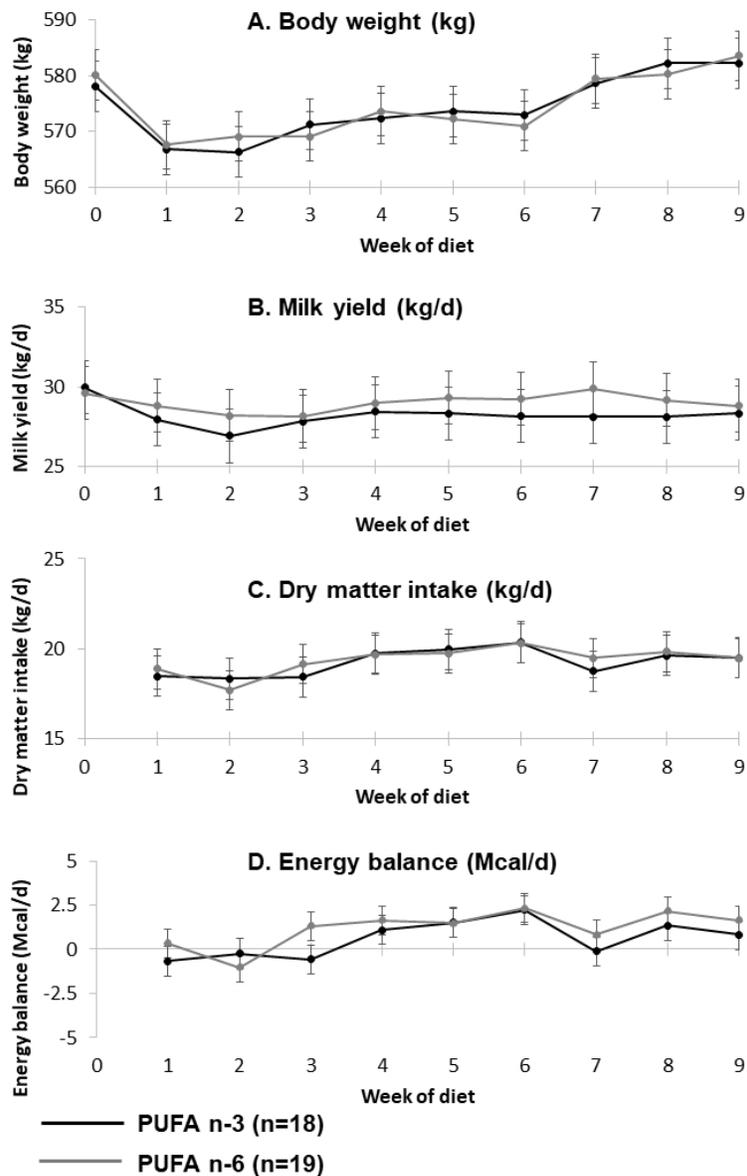


Figure 2: Physiological measurements – Body weight (A), milk yield (B), dry matter intake (C) and energy balance (D) were monitored in 37 primiparous Holstein cows (n-3, n = 18; n-6, n = 19). Cows received either a PUFA n-3 diet (black line) or a PUFA n-6 diet (gray line) for 9 weeks. Results are presented as \bar{x} means \pm SEM. * indicates a difference ($p < 0.05$); # indicates a tendency ($p < 0.10$).

190x275mm (96 x 96 DPI)

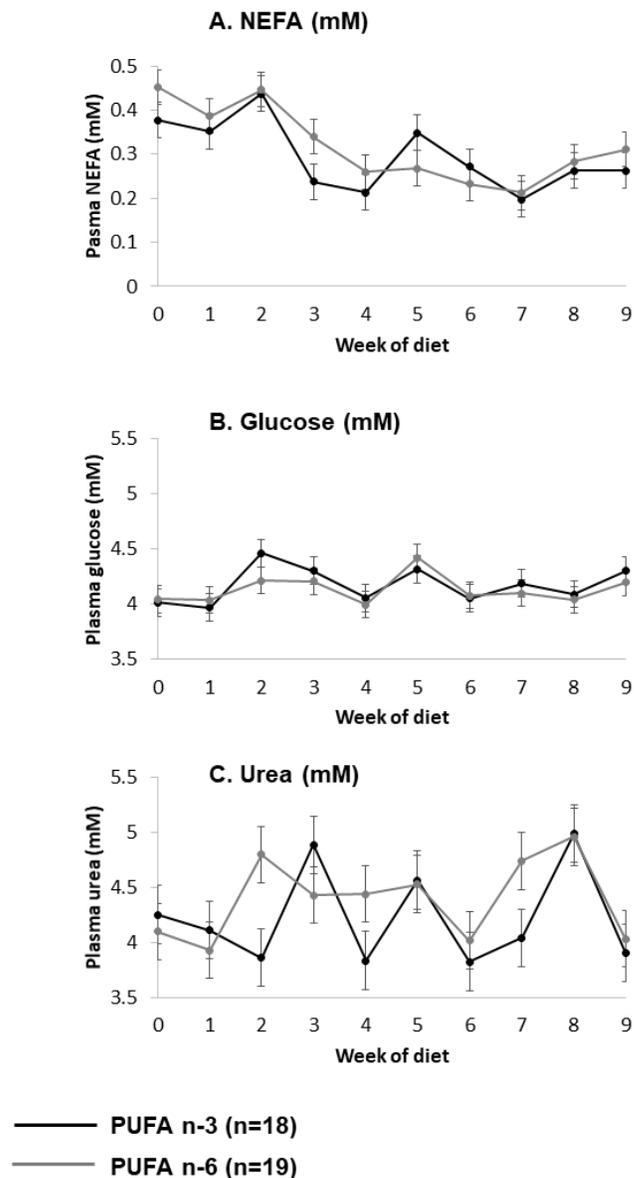


Figure 3: Metabolic measurements – Plasma NEFA (A), glucose (B) and urea (C) levels were monitored once per week in 37 primiparous Holstein cows (n-3, n = 18; n-6, n = 19). Cows received either a PUFA n-3 diet (black line) or a PUFA n-6 diet (gray line) for 9 weeks. Results are presented as $\text{Ismans} \pm \text{SEM}$. * indicates a difference ($p < 0.05$); # indicates a tendency ($p < 0.10$).

190x275mm (96 x 96 DPI)

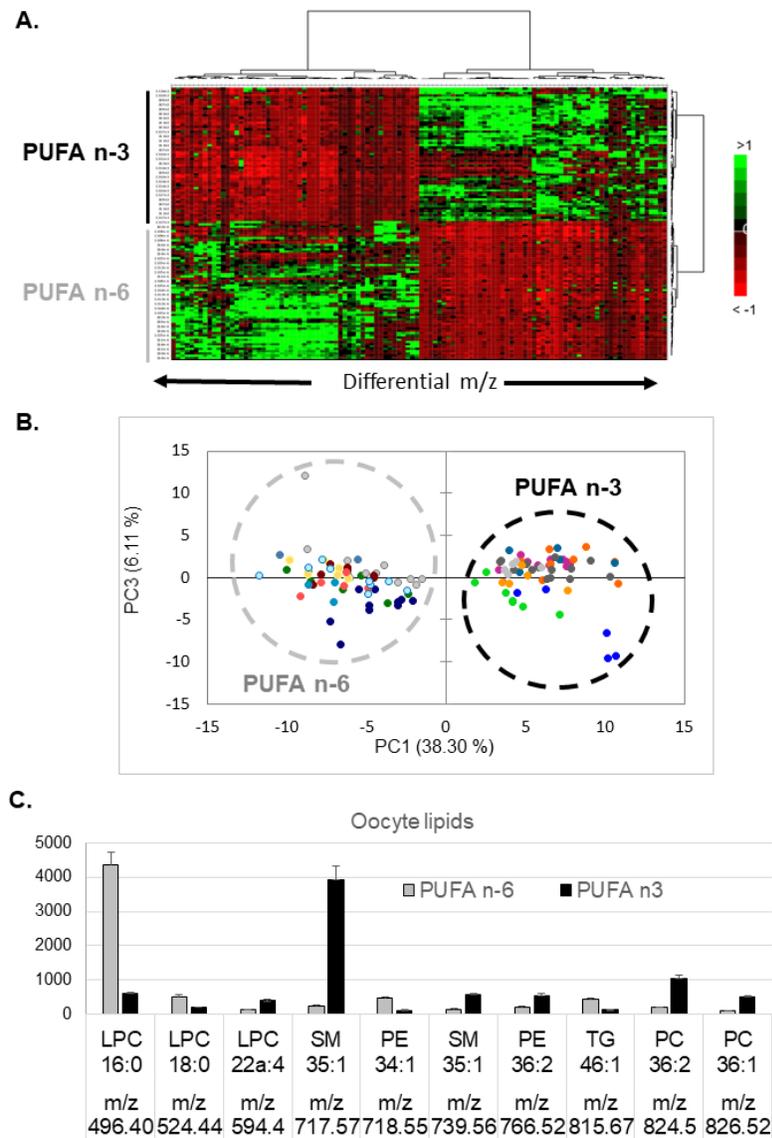


Figure 4: Oocyte lipid composition – 60 oocytes and 61 oocytes, originating from 9 n-3 cows and 9 n-6 cows, respectively, underwent individual lipid analysis by MALDI-TOF mass spectrometry. (A) Hierarchical clustering representing the 110 m/z that exhibited a differential abundance between n-3 and n-6 oocytes (higher abundance represented in green and lower abundance in red). (B) Principle component analysis performed on n-3 and n-6 oocytes. (C) Examples of identified lipids that were either up-regulated or down-regulated in n-3 oocytes. LPC: lyso-phosphatidylcholine; SM: sphingomyelins; PC: phosphatidylcholines; PE: phosphatidylethanolamines; TG: triacylglycerols.

190x275mm (96 x 96 DPI)

Table 1: Effect of a PUFA n-3 ($n = 18$) or PUFA n-6 diet ($n = 19$) on plasma fatty acid (FA) composition (% of total fatty acid), expressed as lsmeans \pm SEM

	Before diet		2 weeks of diet		5 weeks of diet		7 weeks of diet		Diet effect	Week of suppl ^o effect	Diet x week of suppl ^o interaction
	n-3	n-6	n-3	n-6	n-3	n-6	n-3	n-6	p-value	p-value	p-value
C14:0	0.74 \pm 0.20	0.72 \pm 0.20	0.72 \pm 0.20 #	0.65 \pm 0.20	0.76 \pm 0.20 *	0.66 \pm 0.20	0.76 \pm 0.20 *	0.64 \pm 0.20	0.03	0.166	0.1685
C15:0	0.86 \pm 0.04	0.81 \pm 0.03	0.81 \pm 0.04 #	0.75 \pm 0.03	0.90 \pm 0.04 *	0.79 \pm 0.03	0.91 \pm 0.04 *	0.80 \pm 0.03	0.0016	0.0008	0.3320
C16:0	16.2 \pm 1.5	16.7 \pm 1.5	18.5 \pm 1.5 #	17.3 \pm 1.5	16.4 \pm 1.5	15.4 \pm 1.5	16.4 \pm 1.5	15.5 \pm 1.5	0.1324	<0.0001	0.242
C18:0	19.4 \pm 1.8	19.9 \pm 1.8	18.7 \pm 1.8	18.9 \pm 1.8	18.4 \pm 1.8	18.2 \pm 1.8	18.7 \pm 1.8	18.7 \pm 1.8	0.8535	0.0036	0.7891
C20:0	0.35 \pm 0.08	0.35 \pm 0.08	0.43 \pm 0.08	0.38 \pm 0.08	0.49 \pm 0.08 *	0.31 \pm 0.08	0.32 \pm 0.08	0.39 \pm 0.08	0.5134	0.6393	0.098
C22:0	0.10 \pm 0.07	0.05 \pm 0.07	0.03 \pm 0.07	0.11 \pm 0.07	0.10 \pm 0.07	0.10 \pm 0.07	0.01 \pm 0.07	0.07 \pm 0.07	0.54	0.4166	0.256
C24:0	0.35 \pm 0.04	0.37 \pm 0.03	0.45 \pm 0.04 *	0.35 \pm 0.03	0.35 \pm 0.04	0.34 \pm 0.03	0.44 \pm 0.04 #	0.37 \pm 0.03	0.0556	0.0826	0.1621
SFA	37.7 \pm 3.2	38.6 \pm 3.2	39.2 \pm 3.2	38.1 \pm 3.2	37.0 \pm 3.2	35.4 \pm 3.2	37.3 \pm 3.2	36.2 \pm 3.2	0.3840	0.0041	0.3867
C14:1	0.52 \pm 0.04 *	0.39 \pm 0.04	0.43 \pm 0.04	0.38 \pm 0.04	0.49 \pm 0.04 *	0.36 \pm 0.04	0.50 \pm 0.04 *	0.40 \pm 0.04	0.0013	0.0826	0.3261
C16:1	1.54 \pm 0.20	1.59 \pm 0.19	1.42 \pm 0.20	1.36 \pm 0.19	1.40 \pm 0.20 *	1.06 \pm 0.19	1.33 \pm 0.20 *	0.91 \pm 0.19	0.0389	<0.0001	0.0027
C18:1	14.5 \pm 0.9	14.9 \pm 0.9	14.1 \pm 0.9	14.0 \pm 0.9	12.0 \pm 0.9	11.3 \pm 0.9	11.9 \pm 0.9 *	10.4 \pm 0.9	0.2282	<0.0001	0.1769
C20:1 n-9	0.10 \pm 0.09	0.12 \pm 0.08	0.10 \pm 0.09	0.17 \pm 0.08	0.07 \pm 0.09 #	0.29 \pm 0.08	0.17 \pm 0.09	0.18 \pm 0.08	0.1191	0.8054	0.6134
C22:1 n-9	0.26 \pm 0.14	0.39 \pm 0.13	0.40 \pm 0.14	0.48 \pm 0.13	0.33 \pm 0.14	0.30 \pm 0.13	0.50 \pm 0.14	0.30 \pm 0.13	0.9625	0.6226	0.4646
C24:1 n-9	0.24 \pm 0.04	0.24 \pm 0.04	0.25 \pm 0.04	0.20 \pm 0.04	0.20 \pm 0.04	0.19 \pm 0.04	0.24 \pm 0.04	0.20 \pm 0.04	0.3278	0.4629	0.6383
MUFA	16.9 \pm 0.9	17.4 \pm 0.9	16.4 \pm 0.9	16.2 \pm 0.9	14.2 \pm 0.9	13.2 \pm 0.9 *	14.3 \pm 0.9	12.1 \pm 0.9	0.1022	<0.0001	0.0215
C18:2 n-6	35.8 \pm 3.2	34.3 \pm 3.1	34.8 \pm 3.2	36.9 \pm 3.1	37.9 \pm 3.2 *	42.2 \pm 3.1	38.4 \pm 3.2 *	42.7 \pm 3.1	0.0161	<0.0001	0.0022
C18:3 n-6	0.80 \pm 0.11 *	0.65 \pm 0.11	0.47 \pm 0.11	0.52 \pm 0.11	0.73 \pm 0.11 *	0.52 \pm 0.11	0.59 \pm 0.11	0.59 \pm 0.11	0.1955	<0.0001	0.0023
C20:3 n-6	1.64 \pm 0.11	1.77 \pm 0.10	1.33 \pm 0.11	1.49 \pm 0.10	1.31 \pm 0.11 *	1.60 \pm 0.10	1.31 \pm 0.11 *	1.61 \pm 0.10	0.0076	<0.0001	0.4576
C20:4 n-6	1.44 \pm 0.26	1.16 \pm 0.26	1.05 \pm 0.26	1.20 \pm 0.26	1.27 \pm 0.26	1.34 \pm 0.26	1.00 \pm 0.26	1.29 \pm 0.26	0.6918	0.1844	0.0597
n-6	39.7 \pm 3.5	37.9 \pm 3.5	37.6 \pm 3.5 #	40.1 \pm 3.5	41.5 \pm 3.5 *	45.7 \pm 3.5	41.3 \pm 3.5 *	46.2 \pm 3.5	0.0081	<0.0001	0.0012
C18:3 n-3	4.09 \pm 0.40	4.25 \pm 0.40	4.30 \pm 0.40 #	3.85 \pm 0.40	4.51 \pm 0.40 #	4.06 \pm 0.40	4.45 \pm 0.40 *	3.89 \pm 0.40	0.0340	0.6004	0.0892
C20:5 n-3	0.72 \pm 0.15	0.84 \pm 0.15	1.45 \pm 0.15 *	0.85 \pm 0.15	1.60 \pm 0.15 *	0.82 \pm 0.15	1.63 \pm 0.15 *	0.78 \pm 0.15	<0.0001	<0.0001	<0.0001
C22:5 n-3	0.74 \pm 0.06	0.81 \pm 0.06	0.78 \pm 0.06	0.72 \pm 0.06	0.85 \pm 0.06 *	0.65 \pm 0.06	0.81 \pm 0.06 *	0.62 \pm 0.06	0.0010	0.2900	0.0002
C22:6 n-3	0.11 \pm 0.04	0.18 \pm 0.04	0.23 \pm 0.04	0.22 \pm 0.04	0.32 \pm 0.04 #	0.21 \pm 0.04	0.34 \pm 0.04 *	0.21 \pm 0.04	0.4164	<0.0001	<0.0001
n-3	5.7 \pm 0.6	6.1 \pm 0.6	6.8 \pm 0.6 *	5.6 \pm 0.6	7.3 \pm 0.6 *	5.7 \pm 0.6	7.2 \pm 0.6 *	5.5 \pm 0.6	<0.0001	0.0033	<0.0001
PUFA	45.4 \pm 4.0	44.0 \pm 4.0	44.4 \pm 4.0	45.8 \pm 4.0	48.8 \pm 4.0 #	51.5 \pm 4.0	48.5 \pm 4.0 *	51.8 \pm 4.0	0.1224	<0.0001	0.0991
n-6 / n-3	7.7 \pm 0.4 *	6.3 \pm 0.4	5.5 \pm 0.4 *	7.2 \pm 0.4	5.9 \pm 0.5 *	8.2 \pm 0.4	6.2 \pm 0.4 *	8.6 \pm 0.4	0.0010	0.0611	<0.0001

n-3: n-3 polyunsaturated fatty acids; n-6: n-6 polyunsaturated fatty acids; week of suppl^o: week of supplementation; SFA = sum of saturated FA; MUFA = sum of monounsaturated FA; PUFA = sum of polyunsaturated FA; n-3 = sum of n-3 FA; n-6 = sum of n-6 FA; C20:5 n-3: eicosapentaenoic acid (EPA); C22:6 n-3: docosahexaenoic acid (DHA); # indicates a tendency ($p < 0.1$) within a row and a stage * indicates a significant difference between diets ($p <$

0.05). The sample size was 18 n-3 and 19 n-6 cows, except for C20:0, C22:0, C24:0, C22:1 n-9, C24:1 n-9 (11 n-3 and 13 n-6 cows) and C20:1 n-9 (8 n-3 and 11 n-6 cows).

For Review Only

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Table 2: Effect of a PUFA n-3 ($n = 18$) or PUFA n-6 diet ($n = 19$) on follicular fluid fatty acid composition (% of total fatty acid), expressed as lsmeans \pm SEM

	2 weeks of diet		5 weeks of diet		7 weeks of diet		Diet effect	Week of suppl ^o effect	Diet x week of suppl ^o interaction
	n-3	n-6	n-3	n-6	n-3	n-6	p-value	p-value	p-value
C14:0	0.88 \pm 0.17	0.84 \pm 0.17	0.98 \pm 0.17	0.90 \pm 0.17	1.02 \pm 0.17	1.02 \pm 0.17	0.6037	0.0046	0.7281
C15:0	0.75 \pm 0.06	0.73 \pm 0.05	0.78 \pm 0.06	0.76 \pm 0.05	0.84 \pm 0.06	0.81 \pm 0.06	0.6625	0.0324	0.9767
C16:0	20.4 \pm 3.2	19.6 \pm 3.2	18.9 \pm 3.2	20.0 \pm 3.2	19.6 \pm 3.2	21.1 \pm 3.2	0.6534	0.5145	0.2928
C18:0	20.3 \pm 4.2	19.6 \pm 4.2	19.8 \pm 4.2	20.8 \pm 4.2	19.3 \pm 4.2	20.0 \pm 4.2	0.7860	0.7052	0.5502
C20:0	0.90 \pm 0.30	0.66 \pm 0.30	0.72 \pm 0.30	0.37 \pm 0.30	0.67 \pm 0.30	0.71 \pm 0.30	0.31	0.3173	0.4216
C22:0	0.74 \pm 0.15	0.62 \pm 0.14	0.72 \pm 0.15	0.65 \pm 0.14	0.82 \pm 0.15 #	0.61 \pm 0.14	0.0824	0.8147	0.5884
C24:0	0.75 \pm 0.14	0.60 \pm 0.14	0.75 \pm 0.14	0.73 \pm 0.14	0.81 \pm 0.14	0.74 \pm 0.14	0.3009	0.3795	0.6699
SFA	43.7 \pm 7.8	41.8 \pm 7.8	41.8 \pm 7.8	43.5 \pm 7.8	42.2 \pm 7.8	44.1 \pm 7.8	0.8058	0.9311	0.2788
C14:1	0.45 \pm 0.09 *	0.37 \pm 0.09	0.47 \pm 0.09 *	0.36 \pm 0.09	0.47 \pm 0.09 *	0.38 \pm 0.09	0.0043	0.7765	0.8179
C16:1	1.29 \pm 0.31	1.33 \pm 0.31	1.33 \pm 0.31	1.08 \pm 0.31	1.29 \pm 0.31	1.03 \pm 0.31	0.2962	0.2950	0.2139
C18:1	14.8 \pm 1.6	14.8 \pm 1.6	12.9 \pm 1.6	11.3 \pm 1.6	11.7 \pm 1.6	11.0 \pm 1.6	0.3971	<0.0001	0.2170
C20:1 n-9	0.12 \pm 0.13	0.25 \pm 0.13	0.21 \pm 0.13	0.14 \pm 0.13	0.12 \pm 0.13	0.33 \pm 0.12	0.4003	0.8346	0.2662
C22:1 n-9	0.04 \pm 0.06 #	0.16 \pm 0.06	0.12 \pm 0.06	0.14 \pm 0.06	0.19 \pm 0.06 #	0.04 \pm 0.06	0.9061	0.8434	0.0119
C24:1 n-9	0.40 \pm 0.05	0.35 \pm 0.05	0.38 \pm 0.05	0.32 \pm 0.05	0.41 \pm 0.05	0.32 \pm 0.05	0.2105	0.8662	0.8527
MUFA	16.9 \pm 1.5	16.9 \pm 1.5	15.1 \pm 1.5 #	13.1 \pm 1.5	13.9 \pm 1.5	12.8 \pm 1.5	0.2839	<0.0001	0.0713
C18:2 n-6	30.0 \pm 6.6	32.5 \pm 6.6	33.1 \pm 6.6	34.9 \pm 6.6	33.8 \pm 6.6	34.8 \pm 6.6	0.2737	0.0081	0.7997
C18:3 n-6	0.38 \pm 0.10	0.39 \pm 0.10	0.44 \pm 0.10	0.42 \pm 0.10	0.53 \pm 0.10	0.49 \pm 0.10	0.7028	0.0790	0.8812
C20:3 n-6	1.51 \pm 0.11	1.59 \pm 0.11	1.29 \pm 0.11	1.35 \pm 0.11	1.40 \pm 0.11	1.47 \pm 0.11	0.4929	0.0936	0.9991
C20:4 n-6	1.84 \pm 0.22	1.66 \pm 0.22	1.60 \pm 0.22	1.56 \pm 0.22	1.57 \pm 0.22	1.35 \pm 0.22	0.0792	0.0449	0.7231
n-6	33.7 \pm 6.9	36.1 \pm 6.9	36.4 \pm 6.9	38.3 \pm 6.9	37.3 \pm 6.9	38.1 \pm 6.9	0.3183	0.0128	0.7415
C18:3 n-3	3.52 \pm 0.82	3.31 \pm 0.81	4.02 \pm 0.82 *	3.37 \pm 0.81	3.97 \pm 0.82 *	3.19 \pm 0.82	0.0038	0.1401	0.1113
C20:5 n-3	1.06 \pm 0.22 *	0.81 \pm 0.22	1.41 \pm 0.22 *	0.77 \pm 0.27	1.51 \pm 0.22 *	0.77 \pm 0.22	<0.0001	0.0033	0.0002
C22:5 n-3	0.85 \pm 0.07	0.82 \pm 0.07	0.86 \pm 0.07 #	0.72 \pm 0.07	0.84 \pm 0.07 #	0.71 \pm 0.07	0.0742	0.4225	0.4006
C22:6 n-3	0.22 \pm 0.10	0.19 \pm 0.10	0.32 \pm 0.10	0.24 \pm 0.10	0.32 \pm 0.10	0.22 \pm 0.10	0.1863	0.0437	0.5507
n-3	5.7 \pm 1.1	5.1 \pm 1.1	6.6 \pm 1.1 *	5.1 \pm 1.1	6.6 \pm 1.1 *	4.8 \pm 1.1	<0.0001	0.0557	0.0021
PUFA	39.4 \pm 7.9	41.2 \pm 7.9	43.0 \pm 7.9	43.3 \pm 7.9	44.0 \pm 7.9	43.0 \pm 7.9	0.8310	0.0117	0.4684
ratio n-6 / n-3	5.9 \pm 1.0	7.2 \pm 1.0	5.6 \pm 1.0	7.6 \pm 1.0	6.5 \pm 1.0 *	10.3 \pm 1.0	0.0003	0.1178	0.4511

n-3: n-3 polyunsaturated fatty acids; n-6: n-6 polyunsaturated fatty acids; week of suppl^o: week of supplementation; SFA = sum of saturated FA; MUFA = sum of monounsaturated FA; PUFA = sum of polyunsaturated FA; n-3 = sum of n-3 FA; and n-6 = sum of n-6 FA; C20:5 n-3: eicosapentaenoic acid (EPA); C22:6 n-3: docosahexaenoic acid (DHA); # indicates a tendency ($p < 0.1$) within a row and a stage * indicates a significant difference between diets ($p < 0.05$). The sample size was 18 n-3 and 19 n-6 cows, except for C20:0, C22:0, C24:0, C22:1 n-9, C24:1 n-9 (11 n-3 and 13 n-6 cows) and C20:1 n-9 (8 n-3 and 9 n-6 cows).

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Table 3: Effect of a PUFA n-3 ($n = 18$) or PUFA n-6 diet ($n = 19$) on rates (%) and mean numbers per OPU-IVF session (Nb) for COC collection and embryo production, expressed as lsmeans \pm SEM

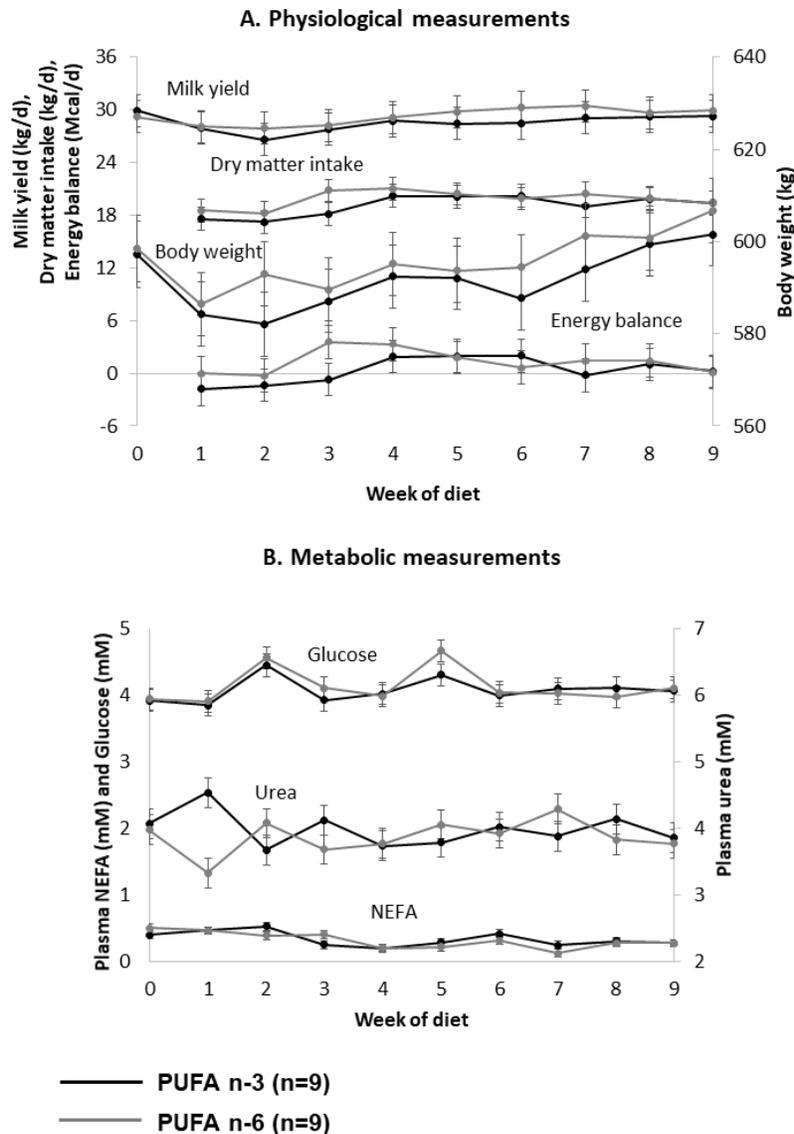
IVM/IVF/IVD	n-3	n-6	2 weeks of diet (OPU session 1)		5 weeks of diet (OPU session 3)		7 weeks of diet (OPU session 4)		Diet effect	Week of suppl ^o effect	Diet x week of suppl ^o interaction
			n-3	n-6	n-3	n-6	n-3	n-6	p-value	p-value	p-value
% Recovered COC	38.0 \pm 1.6 *	32.8 \pm 1.6	42.0 \pm 2.5 #	36.5 \pm 2.5	38.4 \pm 2.4 *	31.2 \pm 2.2	33.7 \pm 2.4	30.8 \pm 2.2	0.0035	0.0054	0.6198
% Oocytes in IVM	76.1 \pm 2.5	73.0 \pm 2.8	73.3 \pm 3.6	70.9 \pm 4.1	79.0 \pm 3.4 *	68.6 \pm 4.2	75.7 \pm 3.9	78.7 \pm 3.6	0.2586	0.3138	0.144
% Cleaved embryos	77.3 \pm 3.8 #	82.3 \pm 3.3	76.6 \pm 4.8	84.7 \pm 4.2	71.3 \pm 5.2	79.3 \pm 5.0	83.0 \pm 4.4	82.7 \pm 4.3	0.1033	0.1268	0.4831
% Embryos >4-cell	53.6 \pm 4.1	55.8 \pm 4.2	50.7 \pm 5.3	54.6 \pm 5.8	50.8 \pm 5.2	54.1 \pm 5.8	59.3 \pm 5.7	54.3 \pm 5.4	0.5649	0.2802	0.8622
% Blastocysts	49.6 \pm 5.5 #	42.3 \pm 5.5	48.5 \pm 6.7 #	37.0 \pm 6.6	52.3 \pm 6.8	43.2 \pm 7.2	47.8 \pm 7.0	46.9 \pm 6.8	0.0865	0.5439	0.528
% Blastocysts Q1-Q2	42.2 \pm 7.7 *	32.7 \pm 7.1	42.2 \pm 8.6 #	30.0 \pm 7.8	43.7 \pm 8.8 *	29.3 \pm 7.9	40.7 \pm 8.9	39.2 \pm 8.6	0.0217	0.6595	0.3499
Nb Punctured follicles	26.7 \pm 4.3	26.1 \pm 4.3	26.5 \pm 4.5	22.5 \pm 4.4	28.1 \pm 4.5	27.5 \pm 4.4	25.7 \pm 4.5	28.3 \pm 4.4	0.8196	0.0674	0.1868
Nb Recovered COC	10.2 \pm 1.3	8.5 \pm 1.3	11.1 \pm 1.5	8.3 \pm 1.5	10.8 \pm 1.5	8.6 \pm 1.5	8.6 \pm 1.5	8.7 \pm 1.5	0.2297	0.5125	0.3641
Nb Oocytes in IVM	7.8 \pm 1.1	6.2 \pm 1.1	8.2 \pm 1.3	5.8 \pm 1.3	8.6 \pm 1.3	5.9 \pm 1.3	6.6 \pm 1.3	6.8 \pm 1.3	0.1729	0.7662	0.166
Nb Cleaved embryos	5.8 \pm 1.0	5.0 \pm 1.0	6.0 \pm 1.1	4.7 \pm 1.1	6.1 \pm 1.1	4.5 \pm 1.1	5.4 \pm 1.1	5.7 \pm 1.1	0.3597	0.9619	0.4046
Nb Embryos > 4-cell	4.1 \pm 0.8	3.4 \pm 0.8	4.1 \pm 0.9	3.1 \pm 0.9	4.4 \pm 0.9	3.2 \pm 0.9	3.7 \pm 0.9	4.1 \pm 0.9	0.4297	0.8714	0.29
Nb Blastocysts	2.8 \pm 0.6	2.2 \pm 0.6	3.0 \pm 0.7	1.8 \pm 0.7	3.1 \pm 0.7	1.9 \pm 0.7	2.5 \pm 0.7	2.8 \pm 0.7	0.2136	0.9005	0.1917
Nb Blastocysts Q1-Q2	2.5 \pm 0.5	1.8 \pm 0.5	2.6 \pm 0.6	1.6 \pm 0.6	2.6 \pm 0.6	1.3 \pm 0.6	2.1 \pm 0.6	2.4 \pm 0.6	0.1527	0.6997	0.1378

%; rates; Nb: number per cow per OPU-IVF session; OPU: ovum pick-up; COC: complex oocyte-cumulus; IVM: *in vitro* maturation; IVF: *in vitro* fertilisation; IVD: *in vitro* development; week of suppl^o: week of supplementation (= rank of OPU session); Blastocysts Q1-Q2: blastocysts of freezable quality according to IETS (International Embryo Technology Society) evaluation criteria; % recovered COC is a ratio to punctured follicles; % Oocytes in IVM is a ratio to recovered COC; rates of cleaved embryos (> 2 cells) and of > 4-cell embryo are ratios to COC in IVM; blastocysts and blastocysts Q1-Q2 are ratios to cleaved embryos. # indicates a tendency ($p < 0.1$) within a row and a stage; * indicates a significant difference between diets ($p < 0.05$). The sample size was 1462 punctured follicles in 18 n-3 cows and 1538 punctured follicles in 19 n-6 cows, corresponding to 54 and 57 OPU sessions, respectively.

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Supplementary Figure 1: Physiological and metabolic measurements - Body weight, milk yield, dry matter intake, energy balance (A) and plasma NEFA, glucose and urea levels (B) were monitored during 9 weeks in 18 (from the 37) primiparous Holstein cows (n-3, n = 9; n-6, n = 9) providing the oocytes analysed by mass spectrometry, for their lipid composition. Cows received either a PUFA n-3 diet (black line) or a PUFA n-6 diet (gray line) for 9 weeks of supplementation. Linear mixed models (MIXED procedure) included the effects of diet, week of supplementation, diet x week of supplementation interaction and week of supplementation as a repeated effect within cow (repeated statement of the MIXED procedure, an AR(1) covariance structure was used for all parameters, except for plasma and follicular fluid FA composition for which a CS covariance structure was used) were used for the following parameters: BW (with BW at 1 week of supplementation as a covariate), MY (with the day in milk corresponding to the first day of supplementation as a covariate), DMI (with BW as a covariate), EB, plasma NEFA, glucose, urea (with, for each of these three parameters, the plasma level measured the first day of supplementation as a covariate). Results are presented as lsmeans \pm SEM. * indicates a difference ($p < 0.05$); # indicates a tendency ($p < 0.10$). No diet effect was found for any measured parameter: BW ($p = 0.5765$), MY ($p = 0.9535$), DMI ($p =$

0.6089), EB ($p = 0.5946$), NEFA ($p = 0.6206$), glucose ($p = 0.4728$) and urea ($p = 0.4339$). A significant week of supplementation effect was found for all parameters, BW ($p < 0.0001$), MY ($p < 0.0001$), DMI ($p = 0.0036$), NEFA ($p < 0.0001$) and glucose ($p = 0.0004$), except for EB ($p = 0.2861$) and urea ($p = 0.9173$).

No interaction between diet and week of supplementation was reported for BW ($p = 0.4493$), MY ($p = 0.4474$), DMI ($p = 0.6284$), EB ($p = 0.4318$), NEFA ($p = 0.0951$) and glucose ($p = 0.9527$). A significant interaction between diet and week of supplementation was only reported for urea ($p = 0.0004$).

190x275mm (96 x 96 DPI)

Supplementary Table 1. Effect of a PUFA n-3 (n = 9) or PUFA n-6 diet (n = 9) on plasma fatty acid composition (% of total fatty acid) of the cows providing oocytes undergoing mass spectrometry lipid analysis, expressed as lsmeans ± SEM

	before diet		2 weeks of diet		5 weeks of diet		7 weeks of diet		diet effect p-value	Week of suppl ^o effect	diet x Week of suppl ^o interaction
	n-3	n-6	n-3	n-6	n-3	n-6	n-3	n-6			
C14:0	0.38 ± 0.05	0.41 ± 0.05	0.34 ± 0.05	0.33 ± 0.05	0.38 ± 0.05	0.32 ± 0.05	0.40 ± 0.05	0.41 ± 0.05	0.6735	0.5446	0.6589
C15:0	0.88 ± 0.04 #	0.76 ± 0.04	0.76 ± 0.04	0.71 ± 0.04	0.91 ± 0.04 *	0.78 ± 0.04	0.90 ± 0.04 #	0.79 ± 0.04	0.0468	0.0047	0.5521
C16:0	17.4 ± 0.9	18.4 ± 0.9	21.5 ± 0.9 *	18.2 ± 0.9	18.1 ± 0.9	16.3 ± 0.9	18.8 ± 0.9 #	16.4 ± 0.9	0.1112	0.0018	0.0202
C18:0	21.7 ± 1.0	23.0 ± 1.0	21.7 ± 1.0	22.3 ± 1.0	21.2 ± 1.0	21.0 ± 1.0	22.2 ± 1.0	21.9 ± 1.0	0.7553	0.272	0.5778
C20:0	0.29 ± 0.08	0.31 ± 0.08	0.43 ± 0.08	0.32 ± 0.08	0.48 ± 0.08	0.30 ± 0.08	0.37 ± 0.08	0.38 ± 0.08	0.478	0.4215	0.2613
C22:0	0.12 ± 0.06	0.09 ± 0.06	0.04 ± 0.06	0.18 ± 0.06	0.12 ± 0.06	0.16 ± 0.06	0.02 ± 0.06	0.11 ± 0.06	0.4294	0.4496	0.2807
C24:0	0.36 ± 0.04	0.39 ± 0.04	0.47 ± 0.04	0.37 ± 0.04	0.38 ± 0.04	0.34 ± 0.04	0.47 ± 0.04	0.39 ± 0.04	0.1749	0.2002	0.2862
SFA	41.1 ± 1.6	43.3 ± 1.6	45.3 ± 1.6	42.4 ± 1.6	41.6 ± 1.6	39.2 ± 1.6	43.1 ± 1.6	40.3 ± 1.6	0.4079	0.0588	0.1273
C14:1	0.52 ± 0.05 *	0.27 ± 0.05	0.36 ± 0.05	0.30 ± 0.05	0.47 ± 0.05 *	0.27 ± 0.05	0.46 ± 0.05	0.34 ± 0.05	0.0033	0.3695	0.1321
C16:1	1.30 ± 0.14	1.24 ± 0.14	1.07 ± 0.14	1.02 ± 0.14	1.10 ± 0.14	0.68 ± 0.14	0.91 ± 0.14	0.52 ± 0.14	0.1262	0.0002	0.2188
C18:1	15.9 ± 0.8	17.0 ± 0.8	16.3 ± 0.8	15.7 ± 0.8	12.3 ± 0.8	12.0 ± 0.8	12.6 ± 0.8	10.7 ± 0.8	0.5642	< 0.0001	0.2331
C20:1 n-9	0.13 ± 0.11	0.14 ± 0.10	0.08 ± 0.11	0.26 ± 0.10	0.08 ± 0.11 #	0.37 ± 0.10	0.05 ± 0.11	0.16 ± 0.10	0.0194	0.7247	0.6541
C22:1 n-9	0.28 ± 0.15	0.23 ± 0.15	0.46 ± 0.15	0.42 ± 0.15	0.28 ± 0.15	0.32 ± 0.15	0.51 ± 0.15	0.30 ± 0.15	0.664	0.4634	0.7989
C24:1 n-9	0.26 ± 0.04	0.28 ± 0.04	0.26 ± 0.04	0.23 ± 0.04	0.22 ± 0.04	0.20 ± 0.04	0.24 ± 0.04	0.24 ± 0.04	0.8735	0.4628	0.9042
MUFA	18.4 ± 0.8	19.2 ± 0.8	18.5 ± 0.8	17.9 ± 0.8	14.4 ± 0.8	13.8 ± 0.8	14.9 ± 0.8	12.3 ± 0.8	0.3869	< 0.0001	0.1212
C18:2 n-6	32.3 ± 1.8	29.5 ± 1.8	28.7 ± 1.8	32.5 ± 1.8	34.3 ± 1.8	39.2 ± 1.8	34.1 ± 1.8	39.7 ± 1.8	0.1727	< 0.0001	0.0111
C18:3 n-6	0.66 ± 0.10	0.42 ± 0.10	0.29 ± 0.10	0.34 ± 0.10	0.72 ± 0.10	0.33 ± 0.10	0.50 ± 0.10	0.41 ± 0.10	0.1622	0.0043	0.0087
C20:3 n-6	1.42 ± 0.15	1.78 ± 0.15	1.24 ± 0.15	1.34 ± 0.15	1.36 ± 0.15	1.63 ± 0.15	1.36 ± 0.15	1.59 ± 0.15	0.146	0.0732	0.7251
C20:4 n-6	1.17 ± 0.27	0.68 ± 0.27	0.28 ± 0.27	0.79 ± 0.27	0.99 ± 0.27	1.02 ± 0.27	0.46 ± 0.27	0.96 ± 0.27	0.6424	0.0936	0.0511
n-6	35.6 ± 1.8	32.4 ± 1.8	30.5 ± 1.8	35.0 ± 1.8	37.8 ± 1.8	42.2 ± 1.8	36.5 ± 1.8	42.7 ± 1.8	0.1345	< 0.0001	0.0049
C18:3 n-3	3.54 ± 0.30	3.53 ± 0.30	3.56 ± 0.30	3.21 ± 0.30	3.93 ± 0.30	3.48 ± 0.30	3.44 ± 0.30	3.31 ± 0.30	0.3286	0.6293	0.8653
C20:5 n-3	0.61 ± 0.09	0.61 ± 0.09	1.22 ± 0.09 *	0.63 ± 0.09	1.19 ± 0.09 *	0.59 ± 0.09	1.22 ± 0.09 *	0.59 ± 0.09	0.0002	< 0.0001	< 0.0001
C22:5 n-3	0.63 ± 0.05 *	0.78 ± 0.05	0.73 ± 0.05	0.62 ± 0.05	0.81 ± 0.05 *	0.52 ± 0.05	0.73 ± 0.05 *	0.59 ± 0.05	0.0331	0.7867	0.0004
C22:6 n-3	0.08 ± 0.08	0.23 ± 0.08	0.18 ± 0.08	0.28 ± 0.08	0.22 ± 0.08	0.24 ± 0.08	0.27 ± 0.08	0.26 ± 0.08	0.55	< 0.0001	0.0005
n-3	4.9 ± 0.3	5.2 ± 0.3	5.7 ± 0.3 *	4.7 ± 0.3	6.2 ± 0.3 *	4.8 ± 0.3	5.7 ± 0.3 #	4.7 ± 0.3	0.0196	0.4726	0.0599
PUFA	40.5 ± 1.9	37.5 ± 1.9	36.2 ± 1.9	39.8 ± 1.9	43.9 ± 1.9	47.0 ± 1.9	42.1 ± 1.9	47.4 ± 1.9	0.2614	< 0.0001	0.0557
ratio 16:0 / 16:1	14.0 ± 3.9	18.3 ± 3.9	23.2 ± 3.9	21.3 ± 3.9	18.8 ± 3.9	27.3 ± 3.9	28.7 ± 3.9	37.9 ± 3.9	0.1498	0.0003	0.4093

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ratio 18:0 / 18:1	1.38 ± 0.14	1.39 ± 0.14	1.35 ± 0.14	1.46 ± 0.14	1.76 ± 0.14	1.80 ± 0.14	1.80 ± 0.14	2.17 ± 0.14	0.4156	< 0.0001	0.1625
ratio n-6 / n-3	8.7 ± 0.8	6.3 ± 0.8	5.3 ± 0.8	7.4 ± 0.8	6.3 ± 0.8	8.9 ± 0.8	7.0 ± 0.8	9.2 ± 0.8	0.1178	0.1735	0.0074

n-3: n-3 polyunsaturated fatty acids; n-6: n-6 polyunsaturated fatty acids; week of suppl^o: week of supplementation; SFA = sum of saturated FA; MUFA = sum of monounsaturated FA; PUFA = sum of polyunsaturated FA; n-3 = sum of n-3 FA; and n-6 = sum of n-6 FA; C20:5 n-3: eicosapentaenoic acid (EPA); C22:6 n-3: docosahexaenoic acid (DHA); # indicates within a row and a stage a tendency ($p < 0.1$) and * indicates a significant difference between both diets ($p < 0.05$).

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Supplementary Table 2. Effect of a PUFA n-3 (n = 9) or PUFA n-6 diet (n = 9) on follicular fluid fatty acid composition (% of total fatty acid) of the cows providing oocytes undergoing mass spectrometry lipid analysis, expressed as lsmeans ± SEM

	2 weeks of diet		5 weeks of diet		7 weeks of diet		diet effect p-value	Week of suppl ^o effect	diet x Week of suppl ^o interaction
	n-3	n-6	n-3	n-6	n-3	n-6			
C14:0	0.62 ± 0.11	0.72 ± 0.11	0.71 ± 0.11	0.80 ± 0.11	0.69 ± 0.11	0.97 ± 0.11	0.2046	0.1999	0.4647
C15:0	0.77 ± 0.09	0.78 ± 0.09	0.77 ± 0.09	0.86 ± 0.09	0.84 ± 0.09	0.97 ± 0.09	0.459	0.1254	0.6847
C16:0	25.3 ± 2.4	25.4 ± 2.4	23.7 ± 2.4	27.8 ± 2.4	25.4 ± 2.4	29.5 ± 2.4	0.3632	0.3354	0.3029
C18:0	27.8 ± 2.6	26.3 ± 2.6	26.6 ± 2.6	30.9 ± 2.6	27.3 ± 2.6	29.3 ± 2.6	0.6497	0.3939	0.0909
C20:0	1.07 ± 0.24	0.82 ± 0.24	0.87 ± 0.24	0.49 ± 0.24	0.80 ± 0.24	0.71 ± 0.24	0.4106	0.3053	0.7127
C22:0	0.77 ± 0.09	0.76 ± 0.09	0.78 ± 0.09	0.77 ± 0.09	0.92 ± 0.09	0.81 ± 0.09	0.6396	0.3217	0.7494
C24:0	0.78 ± 0.11	0.72 ± 0.11	0.83 ± 0.11	0.88 ± 0.11	0.88 ± 0.11	0.87 ± 0.11	0.948	0.3859	0.8698
SFA	57.1 ± 4.8	55.4 ± 4.8	54.3 ± 4.8	62.5 ± 4.8	56.8 ± 4.8	63.1 ± 4.8	0.5065	0.2766	0.0847
C14:1	0.31 ± 0.05	0.27 ± 0.05	0.33 ± 0.05	0.26 ± 0.05	0.33 ± 0.05	0.29 ± 0.05	0.3419	0.8278	0.8771
C16:1	0.64 ± 0.21	0.77 ± 0.21	0.93 ± 0.21	0.53 ± 0.21	0.73 ± 0.21	0.59 ± 0.21	0.5714	0.8974	0.2625
C18:1	15.4 ± 1.8	15.6 ± 1.8	14.0 ± 1.8	11.3 ± 1.8	12.7 ± 1.8	11.1 ± 1.8	0.575	0.0002	0.2027
C20:1 n-9	0.10 ± 0.14 #	0.46 ± 0.15	0.27 ± 0.14	0.26 ± 0.15	0.13 ± 0.14 *	0.55 ± 0.14	0.0883	0.8174	0.2417
C22:1 n-9	0.06 ± 0.05	0.09 ± 0.05	0.06 ± 0.05	0.11 ± 0.05	0.14 ± 0.05	0.02 ± 0.05	0.7994	0.9637	0.138
C24:1 n-9	0.41 ± 0.06	0.38 ± 0.06	0.39 ± 0.06	0.32 ± 0.06	0.40 ± 0.06	0.30 ± 0.06	0.3655	0.596	0.781
MUFA	16.9 ± 1.8	17.4 ± 1.8	15.9 ± 1.8	12.7 ± 1.8	14.4 ± 1.8	12.7 ± 1.8	0.5564	< 0.0001	0.057
C18:2 n-6	18.9 ± 3.0	20.7 ± 3.0	22.4 ± 3.0	19.2 ± 3.0	20.8 ± 3.0	18.5 ± 3.0	0.7452	0.7725	0.305
C18:3 n-6	0.19 ± 0.11	0.16 ± 0.11	0.31 ± 0.11	0.23 ± 0.11	0.51 ± 0.11	0.36 ± 0.11	0.3553	0.0627	0.8472
C20:3 n-6	1.33 ± 0.20	1.50 ± 0.20	1.22 ± 0.20	1.18 ± 0.20	1.67 ± 0.20	1.40 ± 0.20	0.7935	0.1977	0.5041
C20:4 n-6	1.61 ± 0.19	1.58 ± 0.19	1.39 ± 0.19	1.40 ± 0.19	1.64 ± 0.19	1.32 ± 0.19	0.4955	0.5494	0.6125
n-6	22.1 ± 3.0	23.9 ± 3.0	25.3 ± 3.0	22.0 ± 3.0	24.7 ± 3.0	21.6 ± 3.0	0.6954	0.9106	0.2143
C18:3 n-3	2.17 ± 0.31	1.83 ± 0.31	2.57 ± 0.31 *	1.58 ± 0.31	2.26 ± 0.31 *	1.39 ± 0.31	0.0698	0.4053	0.1979
C20:5 n-3	0.81 ± 0.10 *	0.51 ± 0.10	0.83 ± 0.10 *	0.43 ± 0.10	0.87 ± 0.10 *	0.48 ± 0.10	0.0079	0.8114	0.6777
C22:5 n-3	0.73 ± 0.10	0.77 ± 0.10	0.81 ± 0.10	0.60 ± 0.10	0.78 ± 0.10	0.67 ± 0.10	0.4056	0.8385	0.2796
C22:6 n-3	0.18 ± 0.07	0.02 ± 0.07	0.19 ± 0.02	0.07 ± 0.02	0.19 ± 0.02	0.03 ± 0.02	0.0753	0.8726	0.9374
n-3	3.9 ± 0.4	3.1 ± 0.4	4.4 ± 0.4 *	2.7 ± 0.4	4.1 ± 0.4 *	2.6 ± 0.4	0.025	0.6813	0.163
PUFA	25.9 ± 3.3	27.1 ± 3.3	29.7 ± 3.3	24.7 ± 3.3	28.8 ± 3.3	24.2 ± 3.3	0.5117	0.9031	0.1918
ratio 16:0 / 16:1	86.6 ± 24.8	65.9 ± 24.8	55.1 ± 24.8	84.1 ± 24.8	93.9 ± 24.8	117.2 ± 24.8	0.6292	0.2939	0.5324
ratio 18:0 / 18:1	2.03 ± 5.56	1.93 ± 5.56	2.24 ± 5.56	13.23 ± 5.56	5.88 ± 5.56	17.51 ± 5.56	0.2506	0.0704	0.2821

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ratio n-6 / n-3	5.7 ± 1.9	7.8 ± 1.9	5.8 ± 1.9	7.9 ± 1.9	7.5 ± 1.9 #	13.0 ± 1.9	0.0301	0.1611	0.6416
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n-3: n-3 polyunsaturated fatty acids; n-6: n-6 polyunsaturated fatty acids; week of suppl^o: week of supplementation; SFA = sum of saturated FA; MUFA = sum of monounsaturated FA; PUFA = sum of polyunsaturated FA; n-3= sum of n-3 FA; and n-6 = sum of n-6 FA; C20:5 n-3: eicosapentaenoic acid (EPA); C22:6 n-3: docosahexaenoic acid (DHA); # indicates within a row and a stage a tendency ($p < 0.1$) and * indicates a significant difference between both diets ($p < 0.05$).

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Supplementary Table 3. Effect of a PUFA n-3 (n=60) or PUFA n-6 diet (n=61) on lipid abundance in individual oocytes. Mean \pm SEM of normalized peak height values

Feature m/z	p-value	PUFA n-6 mean \pm SEM	Mean n-3 \pm SEM	ratio n3/n6	Feature	p-value	PUFA n-6 mean \pm SEM	Mean n-3 \pm SEM	ratio n3/n6
m/z 166.16	1.74E-09	129 \pm 14	33 \pm 2	0.259	m/z 169.21	0.00E+00	233 \pm 17	917 \pm 65	3.921
m/z 167.20	0.00E+00	243 \pm 14	40 \pm 2	0.165	m/z 179.20	3.76E-06	243 \pm 12	735 \pm 98	3.019
m/z 174.15	3.91E-04	580 \pm 89	238 \pm 12	0.409	m/z 189.17	0.00E+00	68 \pm 3	215 \pm 10	3.136
m/z 175.17	1.71E-12	6406 \pm 747	293 \pm 34	0.045	m/z 190.14	0.00E+00	96 \pm 5	10340 \pm 1064	106.8
m/z 191.08	1.63E-05	613 \pm 120	50 \pm 3	0.082	m/z 199.22	1.08E-09	50 \pm 2	451 \pm 59	8.916
m/z 196.12	1.10E-04	771 \pm 162	93 \pm 7	0.121	m/z 202.16	0.00E+00	38 \pm 2	109 \pm 6	2.834
m/z 219.21	0.00E+00	8509 \pm 721	46 \pm 2	0.005	m/z 212.09	5.39E-06	109 \pm 19	721 \pm 124	6.595
m/z 227.19	2.31E-14	292 \pm 25	55 \pm 4	0.191	m/z 229.70	0.00E+00	70 \pm 4	9330 \pm 866	132.0
m/z 243.20	0.00E+00	4710 \pm 348	33 \pm 1	0.007	m/z 237.24	0.00E+00	28 \pm 1	215 \pm 15	7.650
m/z 244.20	0.00E+00	1251 \pm 112	60 \pm 3	0.048	m/z 239.18	0.00E+00	48 \pm 2	151 \pm 9	3.090
m/z 245.21	0.00E+00	1100 \pm 55	73 \pm 3	0.066	m/z 247.37	0.00E+00	71 \pm 3	5073 \pm 366	70.87
m/z 257.22	0.00E+00	724 \pm 40	106 \pm 8	0.147	m/z 248.38	0.00E+00	53 \pm 4	1122 \pm 69	20.94
m/z 261.21	0.00E+00	1205 \pm 65	79 \pm 3	0.066	m/z 251.12	0.00E+00	188 \pm 37	1060 \pm 56	5.638
m/z 269.22	0.00E+00	898 \pm 76	103 \pm 6	0.115	m/z 265.20	0.00E+00	101 \pm 5	766 \pm 53	7.514
m/z 271.24	0.00E+00	6886 \pm 435	127 \pm 8	0.018	m/z 266.25	0.00E+00	454 \pm 26	1191 \pm 69	2.622
m/z 281.24	0.00E+00	2225 \pm 209	44 \pm 1	0.019	m/z 274.38	0.00E+00	175 \pm 9	491 \pm 29	2.805
m/z 284.28	1.40E-10	1014 \pm 124	104 \pm 4	0.102	m/z 277.22	0.00E+00	45 \pm 1	825 \pm 66	18.07
m/z 287.23	0.00E+00	43724 \pm 2726	195 \pm 14	0.004	m/z 279.22	0.00E+00	196 \pm 11	6951 \pm 425	35.29
m/z 303.21	0.00E+00	2186 \pm 132	595 \pm 52	0.272	m/z 295.19	4.39E-13	299 \pm 17	2419 \pm 254	8.081
m/z 309.20	0.00E+00	809 \pm 51	254 \pm 12	0.314	m/z 304.41	0.00E+00	1451 \pm 158	46978 \pm 2640	32.35
m/z 321.24	0.00E+00	3838 \pm 260	105 \pm 4	0.027	m/z 311.21	0.00E+00	233 \pm 11	2089 \pm 132	8.936
m/z 324.93	0.00E+00	492 \pm 31	84 \pm 5	0.172	m/z 312.46	1.20E-08	338 \pm 39	1312 \pm 150	3.878

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m/z 326.47	1.07E-03	2149 ± 589	91 ± 4	0.042	m/z 316.42	0.00E+00	108 ± 5	879 ± 49	8.110
m/z 329.17	0.00E+00	1689 ± 104	482 ± 27	0.285	m/z 317.20	0.00E+00	102 ± 9	243 ± 8	2.370
m/z 343.14	3.66E-08	2369 ± 357	183 ± 6	0.077	m/z 318.22	0.00E+00	104 ± 9	291 ± 12	2.782
m/z 350.21	0.00E+00	529 ± 33	117 ± 4	0.221	m/z 327.47	0.00E+00	849 ± 108	3992 ± 285	4.700
m/z 358.10	0.00E+00	6639 ± 641	222 ± 15	0.033	m/z 332.42	1.04E-02	473 ± 70	2125 ± 611	4.484
m/z 359.12	2.05E-15	6113 ± 604	341 ± 19	0.055	m/z 335.20	3.75E-11	128 ± 8	958 ± 111	7.436
m/z 365.20	0.00E+00	69951 ± 5264	1088	0.137	m/z 336.18	7.05E-13	116 ± 11	244 ± 10	2.099
m/z 369.50	9.50E-04	730 ± 180	93 ± 4	0.128	m/z 337.19	0.00E+00	288 ± 12	1672 ± 110	5.806
m/z 381.18	9.88E-14	5427 ± 584	316 ± 24	0.058	m/z 338.23	3.07E-04	159 ± 7	428 ± 70	2.687
m/z 385.70	1.65E-03	249 ± 43	102 ± 4	0.410	m/z 341.48	9.19E-09	137 ± 21	294 ± 11	2.140
m/z 387.19	7.63E-13	390 ± 28	145 ± 5	0.372	m/z 354.11	4.08E-06	275 ± 16	1885 ± 325	6.841
m/z 395.20	0.00E+00	215 ± 8	101 ± 4	0.469	m/z 362.19	6.42E-14	77 ± 3	467 ± 44	6.069
m/z 397.23	8.41E-12	830 ± 69	275 ± 12	0.331	m/z 368.51	9.71E-08	1644 ± 668	8951 ± 1059	5.444
m/z 398.75	9.50E-04	674 ± 154	130 ± 5	0.192	m/z 371.15	1.07E-15	288 ± 17	1012 ± 73	3.512
m/z 401.22	5.38E-05	348 ± 52	117 ± 4	0.337	m/z 376.41	0.00E+00	296 ± 30	71088 ± 6435	240.1
m/z 405.07	1.04E-06	408 ± 54	106 ± 14	0.261	m/z 378.36	3.04E-15	97 ± 4	809 ± 76	8.329
m/z 419.20	0.00E+00	612 ± 41	59 ± 2	0.097	m/z 379.21	0.00E+00	146 ± 5	591 ± 35	4.028
m/z 423.18	2.05E-15	239 ± 14	95 ± 4	0.398	m/z 380.21	8.68E-07	98 ± 4	399 ± 56	4.035
m/z 438.33	7.13E-03	430 ± 94	156 ± 10	0.364	m/z 391.46	4.95E-15	137 ± 6	3896 ± 409	28.38
m/z 461.16	7.90E-04	2491 ± 598	344 ± 18	0.138	m/z 394.21	3.28E-07	127 ± 6	672 ± 98	5.258
m/z 468.33	3.65E-06	362 ± 47	119 ± 5	0.331	m/z 400.48	0.00E+00	79 ± 8	228 ± 8	2.877
m/z 494.62	6.96E-03	557 ± 155	110 ± 5	0.197	m/z 403.19	0.00E+00	168 ± 12	964 ± 66	5.724
m/z 495.12	4.72E-03	841 ± 189	269 ± 13	0.320	m/z 404.45	2.38E-04	124 ± 17	342 ± 53	2.743
m/z 496.40	0.00E+00	4354 ± 351	613 ± 30	0.140	m/z 413.16	3.48E-08	109 ± 9	429 ± 52	3.935
m/z 498.33	0.00E+00	330 ± 15	123 ± 4	0.374	m/z 414.52	0.00E+00	63 ± 5	476 ± 26	7.529
m/z 517.13	2.05E-15	852 ± 70	176 ± 7	0.206	m/z 447.21	5.53E-07	125 ± 5	457 ± 61	3.646
m/z 522.64	9.13E-06	1985 ± 368	211 ± 15	0.106	m/z 451.20	0.00E+00	96 ± 4	281 ± 14	2.925

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m/z 524.44	2.16E-06	511 ± 58	207 ± 7	0.406	m/z 452.53	0.00E+00	80 ± 6	286 ± 17	3.567
m/z 527.20	1.31E-10	21254 ± 2872	297 ± 23	0.014	m/z 481.20	1.45E-03	534 ± 30	1253 ± 213	2.345
m/z 533.17	1.67E-13	8239 ± 861	781 ± 59	0.094	m/z 493.67	1.51E-09	111 ± 5	277 ± 24	2.497
m/z 543.18	1.46E-10	1753 ± 195	325 ± 13	0.185	m/z 505.19	1.29E-11	168 ± 8	443 ± 34	2.631
m/z 577.56	5.98E-13	353 ± 24	137 ± 7	0.388	m/z 508.43	6.25E-13	242 ± 33	4350 ± 497	17.97
m/z 603.56	1.03E-04	364 ± 51	148 ± 6	0.408	m/z 536.17	0.00E+00	181 ± 37	1811 ± 145	9.983
m/z 609.55	3.82E-05	331 ± 45	121 ± 11	0.367	m/z 545.18	4.97E-12	340 ± 23	16378 ± 2049	48.10
m/z 617.11	2.73E-07	336 ± 35	134 ± 5	0.401	m/z 547.19	1.68E-12	133 ± 6	6411 ± 780	47.89
m/z 623.16	6.81E-04	1139 ± 225	304 ± 46	0.267	m/z 559.25	0.00E+00	154 ± 6	455 ± 27	2.949
m/z 640.64	1.27E-05	644 ± 83	244 ± 12	0.378	m/z 561.18	7.84E-12	122 ± 5	528 ± 52	4.307
m/z 642.61	9.98E-05	588 ± 98	175 ± 7	0.298	m/z 562.55	5.19E-05	132 ± 19	266 ± 23	2.007
m/z 650.42	1.10E-11	556 ± 45	172 ± 18	0.310	m/z 579.21	1.39E-05	183 ± 10	419 ± 49	2.285
m/z 666.39	5.09E-12	592 ± 55	143 ± 9	0.242	m/z 594.40	1.89E-10	146 ± 8	396 ± 33	2.705
m/z 668.67	8.49E-05	695 ± 108	229 ± 20	0.330	m/z 639.14	5.18E-03	226 ± 15	504 ± 93	2.228
m/z 677.04	4.93E-12	360 ± 25	144 ± 10	0.401	m/z 654.65	3.70E-03	139 ± 9	284 ± 46	2.041
m/z 688.48	2.25E-13	232 ± 13	108 ± 5	0.465	m/z 659.59	1.49E-02	139 ± 5	395 ± 100	2.825
m/z 689.20	2.38E-07	2367 ± 376	221 ± 16	0.093	m/z 664.59	4.52E-11	176 ± 13	654 ± 63	3.712
m/z 703.57	1.06E-13	7508 ± 663	206	0.193	m/z 679.10	1.02E-07	225 ± 13	710 ± 82	3.144
m/z 706.53	0.00E+00	3961 ± 340	245 ± 23	0.062	m/z 681.17	1.22E-07	186 ± 11	910 ± 125	4.884
m/z 718.55	0.00E+00	480 ± 33	125 ± 5	0.261	m/z 702.52	1.54E-13	124 ± 7	267 ± 14	2.151
m/z 719.56	1.20E-10	370 ± 23	184 ± 10	0.497	m/z 709.15	2.50E-07	114 ± 5	411 ± 52	3.590
m/z 720.55	0.00E+00	2372 ± 188	130 ± 6	0.055	m/z 716.49	0.00E+00	217 ± 24	7875 ± 774	36.15
m/z 725.54	4.55E-11	1547 ± 133	428 ± 66	0.276	m/z 717.57	0.00E+00	258 ± 21	3935 ± 371	15.20
m/z 732.54	1.41E-09	5436 ± 451	161	0.401	m/z 738.58	2.06E-12	119 ± 6	1849 ± 216	15.45
m/z 734.55	0.00E+00	19068 ± 1686	213 ± 9	0.011	m/z 739.56	2.05E-14	161 ± 9	564 ± 44	3.497
m/z 748.56	0.00E+00	1438 ± 130	119 ± 6	0.083	m/z 740.54	7.63E-13	167 ± 8	520 ± 42	3.099

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m/z 758.54	0.00E+00	10011 ± 797	1476 ± 110	0.147	m/z 744.55	0.00E+00	527 ± 34	6213 ± 539	11.78
m/z 760.57	0.00E+00	28790 ± 2199	165 ± 11	0.005	m/z 746.56	0.00E+00	2165 ± 164	18983 ± 1490	8.764
m/z 780.53	5.43E-09	1542 ± 134	593 ± 57	0.384	m/z 766.52	1.11E-06	223 ± 11	554 ± 62	2.483
m/z 782.54	0.00E+00	5863 ± 432	444 ± 34	0.075	m/z 768.55	7.94E-06	515 ± 33	1177 ± 134	2.284
m/z 784.56	0.00E+00	3560 ± 254	787 ± 50	0.221	m/z 770.54	2.05E-14	407 ± 21	2654 ± 251	6.520
m/z 786.58	0.00E+00	4961 ± 367	1225 ± 95	0.247	m/z 772.55	0.00E+00	808 ± 55	8746 ± 708	10.81
m/z 788.59	0.00E+00	1668 ± 134	277 ± 17	0.166	m/z 774.59	0.00E+00	1050 ± 76	32854 ± 2308	31.28
m/z 804.52	2.40E-10	733 ± 56	295 ± 22	0.402	m/z 794.55	2.93E-09	279 ± 17	1605 ± 201	5.749
m/z 808.55	0.00E+00	1587 ± 109	436 ± 37	0.275	m/z 796.54	7.03E-14	433 ± 26	6601 ± 711	15.24
m/z 810.58	7.12E-11	1112 ± 77	487 ± 32	0.438	m/z 798.52	0.00E+00	499 ± 38	3419 ± 273	6.846
m/z 813.65	6.57E-12	599 ± 44	236 ± 10	0.394	m/z 800.55	0.00E+00	222 ± 12	4600 ± 343	20.70
m/z 815.67	5.97E-14	432 ± 33	129 ± 6	0.299	m/z 802.51	0.00E+00	123 ± 6	1843 ± 134	14.93
m/z 893.52	4.12E-12	291 ± 23	99 ± 4	0.343	m/z 821.18	3.96E-09	219 ± 19	827 ± 91	3.761
m/z 909.49	2.56E-11	232 ± 15	110 ± 5	0.474	m/z 823.47	6.77E-15	213 ± 19	1859 ± 179	8.695
m/z 950.51	2.42E-10	378 ± 34	124 ± 6	0.329	m/z 824.50	0.00E+00	213 ± 14	1058 ± 82	4.971
m/z 966.48	4.58E-12	223 ± 17	81 ± 3	0.363	m/z 825.52	2.37E-14	121 ± 6	735 ± 68	6.069
					m/z 826.52	2.49E-13	115 ± 9	509 ± 45	4.421
					m/z 859.15	7.59E-07	139 ± 7	279 ± 25	2.010
					m/z 865.18	4.89E-14	92 ± 4	249 ± 17	2.686
					m/z 943.57	8.60E-15	80 ± 3	182 ± 10	2.274
					m/z 962.50	7.68E-11	92 ± 5	204 ± 14	2.216
					m/z 976.52	2.37E-12	122 ± 6	308 ± 22	2.512

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Supplementary Table 4. Identification of lipid features detected by MALDI-TOF MS profiling in the oocytes after PUFA n-3 (n = 9 cows) or n-6 (n = 9 cows) diet

Feature m/z	Lipid ID	adduct	m/z theoretical	Delta theoretical/observed	ratio n3/n6 relative abundance
m/z 496.40	LPC (16:0)	[M+H] ⁺	496.3398	-0.0602	0.141
m/z 524.44	LPC (18:0)	[M+H] ⁺	524.3711	-0.0689	0.406
m/z 594.4	LPC (22:4)	[M+Na] ⁺	594.3530	-0.0470	2.706
m/z 703.57	SM (d34:1)	[M+H] ⁺	703.5748	0.0048	0.194
m/z 703.57	CE (20:0)	[M+Na] ⁺	703.6363	0.0663	
m/z 706.53	PC (30:0)	[M+H] ⁺	706.5381	0.0081	0.062
m/z 706.53	PC (O-31:0)	[M+H] ⁺	706.5745	0.0445	
m/z 717.57	SM (d35:1)	[M+H] ⁺	717.5905	0.0205	15.205
m/z 717.57	CE (20:1)	[M+K] ⁺	717.5946	0.0246	
m/z 718.55	PE (34:1)	[M+H] ⁺	718.5381	-0.0119	0.261
m/z 718.55	PC (31:1)	[M+H] ⁺	718.5381	-0.0119	
m/z 718.55	PC (O-32:1) / PC (P-32:0)	[M+H] ⁺	718.5745	0.0245	
m/z 720.55	PC (31:0)	[M+H] ⁺	720.5538	0.0038	0.055
m/z 720.55	PC (O-32:0)	[M+H] ⁺	720.5902	0.0402	
m/z 725.54	SM (d34:1)	[M+Na] ⁺	725.5568	0.0168	0.277
m/z 725.54	SM (d33:2)	[M+K] ⁺	725.4994	-0.0406	
m/z 732.54	PC (32:1)	[M+H] ⁺	732.5538	0.0138	0.401
m/z 732.54	PC (O-33:1) / PC (P-33:0)	[M+H] ⁺	732.5902	0.0502	
m/z 734.55	PC (32:0)	[M+H] ⁺	734.5694	0.0194	0.011
m/z 734.55	PC (31:4)	[M+Na] ⁺	734.4731	-0.0769	
m/z 739.56	SM (d35:1)	[M+Na] ⁺	739.5724	0.0124	3.498
m/z 739.56	SM (d34:2)	[M+K] ⁺	739.5151	-0.0449	
m/z 739.56	CE 22:4	[M+K] ⁺	739.5790	0.0190	
m/z 740.54	PC (31:1)	[M+Na] ⁺	740.5201	-0.0199	3.099
m/z 740.54	PE (34:1)	[M+Na] ⁺	740.5201	-0.0199	
m/z 740.54	PC (O-32:1) / PC (P-32:0)	[M+Na] ⁺	740.5560	0.016	
m/z 744.55	PE (36:2)	[M+H] ⁺	744.5538	0.0038	11.789
m/z 744.55	PC (30:0)	[M+K] ⁺	744.494	-0.056	
m/z 744.55	PC (O-31:0)	[M+K] ⁺	744.5305	-0.0195	
m/z 746.56	PE (36:1)	[M+H] ⁺	746.5694	0.0094	8.764
m/z 746.56	PC (33:1)	[M+H] ⁺	746.5694	0.0094	
m/z 746.56	PC (O-34:1) / PC (P-34:0)	[M+H] ⁺	746.6058	0.0458	
m/z 746.56	PC (O-33:5) / PC (P-33:4)	[M+Na] ⁺	746.5101	-0.0499	
m/z 748.56	PC(33:0)	[M+H] ⁺	748.5851	0.0251	0.083
m/z 748.56	PC (O-35:7) / PC (P-35:6)	[M+H] ⁺	748.5281	-0.0319	

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m/z 748.56	PC (O-34:0)	[M+H] ⁺	748.6215	0.0615	
m/z 748.56	PC (O-33:4) / PC (P-33:3)	[M+Na] ⁺	748.5257	-0.0343	
m/z 758.54	PC(34:2)	[M+H] ⁺	758.5694	0.0294	0.147
m/z 758.54	PC (O-35:2) / PC (P-35:1)	[M+H] ⁺	758.6058	0.0658	
m/z 758.54	PC (31:0)	[M+K] ⁺	758.5097	-0.0303	
m/z 758.54	PC (O-32:0)	[M+K] ⁺	758.5460	0.0060	
m/z 760.57	PC(34:1)	[M+H] ⁺	760.5848	0.0148	0.006
m/z 760.57	PC (33:5)	[M+Na] ⁺	760.4888	-0.0812	
m/z 760.57	PC (O-34:5) / PC (P-34:4)	[M+Na] ⁺	760.5252	-0.0448	
m/z 760.57	PE (36 :5)	[M+Na] ⁺	760.488	-0.0812	
m/z 766.52	PE (36:2)	[M+Na] ⁺	766.5357	0.0157	2.483
m/z 766.52	PC (33:2)	[M+Na] ⁺	766.5357	0.0157	
m/z 766.52	PC (35:5)	[M+H] ⁺	766.5381	0.0181	
m/z 766.52	PC (O-36:5) / PC (P-36:4)	[M+H] ⁺	766.5745	0.0545	
m/z 766.52	PC (O-34:2) / PC (P-34:1)	[M+Na] ⁺	766.5721	0.0521	
m/z 766.52	PC (O-33:3) / PC (P-33:2)	[M+K] ⁺	766.5147	-0.0053	
m/z 768.55	PC (33:1)	[M+Na] ⁺	768.5514	0.0014	2.285
m/z 768.55	PC (35:4)	[M+H] ⁺	768.5538	0.0038	
m/z 768.55	PC (O-36:4) / PC (P-36:3)	[M+H] ⁺	768.5902	0.0402	
m/z 768.55	PC (O-34:1) / PC (P-34:0)	[M+Na] ⁺	768.5878	0.0378	
m/z 768.55	PC (32:2)	[M+K] ⁺	768.4940	-0.0560	
m/z 768.55	PC (O-33:2) / PC (P-33:1)	[M+K] ⁺	768.5304	-0.0196	
m/z 768.55	PE (36:1)	[M+Na] ⁺	768.5514	0.0014	
m/z 770.54	PC (33:0)	[M+Na] ⁺	770.5670	0.0270	6.520
m/z 770.54	PC (35:3)	[M+H] ⁺	770.5694	0.0294	
m/z 770.54	PC (O-36:3) / PC (P-36:2)	[M+H] ⁺	770.6058	0.0658	
m/z 770.54	PC (O-35:7) / PC (P-35:6)	[M+Na] ⁺	770.5101	-0.0299	
m/z 770.54	PC (O-34:0)	[M+Na] ⁺	770.6034	0.0634	
m/z 770.54	PC (32:1)	[M+K] ⁺	770.5097	-0.0303	
m/z 770.54	PC (O-33:1) / PC (P-33:0)	[M+K] ⁺	770.5460	0.0060	
m/z 772.55	PC (32:0)	[M+K] ⁺	772.5253	-0.0247	10.814
m/z 772.55	PC (35:2)	[M+H] ⁺	772.5851	0.0351	
m/z 772.55	PC (O-36:2) / PC (P-36:1)	[M+H] ⁺	772.6215	0.0715	
m/z 772.55	PC (O-35:6) / PC (P-35:5)	[M+Na] ⁺	772.5257	-0.0243	
m/z 774.59	PC (34:5)	[M+Na] ⁺	774.5044	-0.0856	31.290

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m/z 774.59	PE (38:1)	[M+H] ⁺	774.6007	0.0107	
m/z 774.59	PC (35:1)	[M+H] ⁺	774.6007	0.0107	
m/z 774.59	PC (O-36:1) / PC (P-36:0)	[M+H] ⁺	774.6371	0.0471	
m/z 774.59	PC (O-35:5) / PC (P-35:4)	[M+Na] ⁺	774.5414	-0.0486	
m/z 780.53	PC (34:2)	[M+Na] ⁺	780.5514	0.0214	0.384
m/z 780.53	PC (36:5)	[M+H] ⁺	780.5538	0.0238	
m/z 780.53	PC (O-37:5) / PC (P-37:4)	[M+H] ⁺	780.5908	0.0607	
m/z 780.53	PC (O-35:2) / PC (P-35:1)	[M+Na] ⁺	780.5878	0.0578	
m/z 780.53	PC (33:3)	[M+K] ⁺	780.4940	-0.0360	
m/z 780.53	PC (O-34:3) / PC (P-34:2)	[M+K] ⁺	780.5304	0.0004	
m/z 782.54	PC (34:1)	[M+Na] ⁺	782.5670	0.0270	0.076
m/z 782.54	PC (36:4)	[M+H] ⁺	782.5694	0.0294	
m/z 782.54	PC (O-37:4) / PC (P-37:3)	[M+H] ⁺	782.6064	0.0664	
m/z 782.54	PC (33:2)	[M+K] ⁺	782.5097	-0.0303	
m/z 782.54	PC (O-34:2) / PC (P-34:1)	[M+K] ⁺	782.5460	0.0060	
m/z 782.54	PE (36:2)	[M+K] ⁺	782.5097	-0.0303	
m/z 784.56	PC (36:3)	[M+H] ⁺	784.5851	0.0251	0.221
m/z 784.56	PC (O-37:3) / PC (P-37:2)	[M+H] ⁺	784.6215	0.0615	
m/z 784.56	PC (34:0)	[M+Na] ⁺	784.5827	0.0227	
m/z 784.56	PC (33:1)	[M+K] ⁺	784.5253	-0.0347	
m/z 784.56	PC (O-34:1) / PC (P-34:0)	[M+K] ⁺	784.5617	0.0017	
m/z 784.56	PE (36:1)	[M+K] ⁺	784.5253	-0.0347	
m/z 786.58	PC (36:2)	[M+H] ⁺	786.6007	0.0207	0.247
m/z 786.58	PC (35:6)	[M+Na] ⁺	786.5044	-0.0756	
m/z 786.58	PC (O-36:6) / PC (P-36:5)	[M+Na] ⁺	786.5408	-0.0392	
m/z 786.58	PC (33:0)	[M+K] ⁺	786.5410	-0.0390	
m/z 786.58	PC (O-34:0)	[M+K] ⁺	786.5773	-0.0027	
m/z 786.58	PC(O-35:7) / PC(P-35:6)	[M+K] ⁺	786.5271	-0.0529	
m/z 788.59	PC (36:1)	[M+H] ⁺	788.6164	0.0264	0.166
m/z 788.59	PC (35:5)	[M+Na] ⁺	788.5201	-0.0699	
m/z 788.59	PC (O-36:5) / PC (P-36:4)	[M+Na] ⁺	788.5565	-0.0335	
m/z 794.55	PC (35:2)	[M+Na] ⁺	794.5670	0.0170	5.750
m/z 794.55	PC (37:5)	[M+H] ⁺	794.5694	0.0194	
m/z 794.55	PC (O-38:5) / PC (P-38:4)	[M+H] ⁺	794.6058	0.0558	
m/z 794.55	PC (O-36:2) / PC (P-36:1)	[M+Na] ⁺	794.6034	0.0534	
m/z 794.55	PC (34:3)	[M+K] ⁺	794.5097	-0.0403	

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m/z 794.55	PC (O-35:3) / PC (P-35:2)	[M+K] ⁺	794.5460	-0.0040	
m/z 796.54	PC (34:2)	[M+K] ⁺	796.5253	-0.0147	15.244
m/z 796.54	PC (35:1)	[M+Na] ⁺	796.5827	0.0427	
m/z 796.54	PC (37:4)	[M+H] ⁺	796.5851	0.0451	
m/z 796.54	PC (O-38:4) / PC (P-38:3)	[M+H] ⁺	796.6215	0.0815	
m/z 796.54	PC (O-36:1) / PC (P-36:0)	[M+Na] ⁺	796.6191	0.0791	
m/z 796.54	PC (O-35:2) / PC (P-35:1)	[M+K] ⁺	796.5617	0.0217	
m/z 796.54	PE (38:1)	[M+Na] ⁺	796.5827	0.0427	
m/z 798.52	PC (34:1)	[M+K] ⁺	798.5410	0.0210	6.846
m/z 798.52	PC (37:3)	[M+H] ⁺	798.6007	0.0807	
m/z 798.52	PC (36:7)	[M+Na] ⁺	798.5044	-0.0156	
m/z 798.52	PC (O-37:7) / PC (P-37:6)	[M+Na] ⁺	798.5414	0.0214	
m/z 798.52	PC (35:0)	[M+Na] ⁺	798.5983	0.0783	
m/z 800.55	PC (36:6)		800.5201		
m/z 800.55	PC(O-37:6) / PC(P-37:5)	[M+Na] ⁺	800.5561	-0.0299	20.707
m/z 800.55	PC (34:0)	[M+Na] ⁺	800.5566	0.0061	
m/z 800.55	PC (37:2)	[M+K] ⁺	800.6158	0.0066	
m/z 800.55	PC (37:2)	[M+H] ⁺	800.6158	0.0658	
m/z 802.51	PC (36:5)		802.5357	0.0257	14.936
m/z 802.51	PC (O-37:5) / PC (P-37:4)	[M+Na] ⁺	802.5718	0.0618	
m/z 802.51	PC (35:6)	[M+Na] ⁺	802.4780	-0.032	
m/z 802.51	PC(O-36:6) / PC(P-36:5)	[M+K] ⁺	802.5139	0.0039	
m/z 802.51	PC (36:5)	[M+K] ⁺	802.5139	0.0039	
m/z 804.52	PC (36:4)	[M+Na] ⁺	804.5514	0.0314	0.402
m/z 804.52	PC (38:7)	[M+H] ⁺	804.5538	0.0338	
m/z 804.52	PC (O-39:7) / PC (P-39:6)	[M+H] ⁺	804.5908	0.0707	
m/z 804.52	PC (O-37:4) / PC (P-37:3)	[M+Na] ⁺	804.5883	0.0683	
m/z 804.52	PC (35:5)	[M+K] ⁺	804.4940	-0.0260	
m/z 804.52	PC (O-36:5) / PC (P-36:4)	[M+K] ⁺	804.5304	0.0104	
m/z 808.55	PC (36:2)	[M+Na] ⁺	808.5827	0.0327	0.275
m/z 808.55	PC (38:5)	[M+H] ⁺	808.5851	0.0351	
m/z 808.55	PC (O-39:5) / PC (P-39:4)	[M+H] ⁺	808.6221	0.0720	
m/z 808.55	PC (35:3)	[M+K] ⁺	808.5253	-0.0247	
m/z 808.55	PC (O-36:3) / PC (P-36:2)	[M+K] ⁺	808.5617	0.0117	
m/z 810.58	PC (36:1)	[M+Na] ⁺	810.5983	0.0183	0.439
m/z 810.58	PC (38:4)	[M+H] ⁺	810.6007	0.0207	
m/z 810.58	PC (35:2)	[M+K] ⁺	810.5410	-0.0390	
m/z 810.58	PC (O-36:2) / PC (P-36:1)	[M+K] ⁺	810.5773	-0.0027	

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m/z 813.65	SM (d42:2)	[M+H] ⁺	813.6844	0.0344	0.395
m/z 813.65	TG (47:1)	[M+Na] ⁺	813.6943	0.0443	
m/z 813.65	TG (46:2)	[M+K] ⁺	813.6369	-0.0131	
m/z 815.67	SM (d42:1)	[M+H] ⁺	815.700	0.030	0.299
m/z 815.67	TG (46:1)	[M+K] ⁺	815.6525	-0.0175	0.299
m/z 824.5	PC (36:2)	[M+K] ⁺	824.5566	0.0566	4.972
m/z 826.52	PC (36:1)	[M+K] ⁺	826.5723	0.0523	4.422
m/z 826.52	PC (38:7)	[M+Na] ⁺	826.5357	0.0157	
m/z 826.52	PC (O-39:7) / PC (P-39:6)	[M+Na] ⁺	826.5727	0.0527	

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