Impact of cannabis use on brain metabolism using ^{31}P and ^{1}H magnetic resonance spectroscopy

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Suppl_Table4: T1 relaxation for Phosphorus MRS

	PE	PC	Pi	GPE	GPC	PCr	ATP	NAD	Phantom
T1 (ms)	4000	3300	2200	4000	2700	3500	1000	1000	4000
R_P	0.36	0.4	0.51	0.36	0.46	0.39	0.71	0.71	0.36

T1 values used for relaxation correction of phosphorus metabolite values and calculated relaxation factors R_P

Suppl_Table5: Results of 31P MRS - Comparison between groups

FGM		overall comparison of groups (multivariate) Statistics MANOVA: Wilks-Lambda p = 0.175						
		pairwise group comparison (post-hoc Scheffé test)						
	omnibus p-value	fN (n=20) mean ± SD	Δmf rel. diff.	Δmf p-value	mN (n=24) mean ± SD	ΔCN rel. diff.	ΔCN p-value	mC (n=34) mean ± SD
PME	0.764	2,70 ± 0,43	-3%	0,802	2,61 ± 0,43	0%	0.997	2,62 ± 0,43
Pi	**0.037**	0,68 ± 0,21	-13%	0,307	0,59 ± 0,17	-9%	0.599	0,54 ± 0,18
PDE	0.254	2,89 ± 0,58	5%	0,599	3,04 ± 0,49	-7%	0.259	2,83 ± 0,44
PCr	0.891	3,65 ± 0,62	-2%	0,893	3,58 ± 0,48	1%	0.984	3,60 ± 0,49
ATP	0.082	2,83 ± 0,49	-5%	0,693	2,70 ± 0,48	-7%	0.400	2,51 ± 0,48
NAD	–	0,38 ± 0,12	-8%	–	0.35 ± 0.14	3%	–	0.36 ± 0.11
pH	0.263	6,98 ± 0,03	0,0%	0,992	6,99 ± 0,02	-0,1%	0.343	6,98 ± 0,02
Mg	0.115	0,11 ± 0,02	-9%	0,148	0,10 ± 0,01	1%	0.923	0,10 ± 0,01

r_TH		overall comparison of groups (multivariate) Statistics MANOVA: Wilks-Lambda p = **0.014**						
		pairwise group comparison (post-hoc Scheffé test)						
	omnibus	**fN (n=21)**	**Δmf**		**mN (n=26)**	**ΔCN**		**mC (n=40)**
	p-value	mean ± SD	rel. diff.	p-value	mean ± SD	rel. diff.	p-value	mean ± SD
PME	**0,010**	2.30 ± 0.33	-15%	**0.014**	1.96 ± 0.40	4%	0.680	2.05 ± 0.39
Pi	0,533	0.79 ± 0.19	-5%	0.825	0.75 ± 0.18	-3%	0.892	0.73 ± 0.24
PDE	0,790	2.61 ± 0.46	-2%	0.939	2.56 ± 0.36	3%	0.790	2.63 ± 0.39
PCr	**0,016**	3.70 ± 0.50	-13%	**0.018**	3.23 ± 0.52	5%	0.558	3.38 ± 0.60
ATP	**0,012**	2,43 ± 0,48	-11%	0,166	2,16 ± 0,44	-6%	0.586	2,03 ± 0,53
NAD	–	0.36 ± 0.10	3%	–	0.37 ± 0.10	0%	–	0.37 ± 0.11
pH	0,413	6.98 ± 0.02	0.2%	0.264	6.99 ± 0.02	0.0%	0.545	6.99 ± 0.03
Mg	0,157	0.10 ± 0.01	9%	0.163	0.11 ± 0.02	-5%	0.469	0.10 ± 0.02

l_TH		overall comparison of groups (multivariate) Statistics MANOVA: Wilks-Lambda p = 0.359						
		pairwise group comparison (post-hoc Scheffé test)						
	omnibus	**fN (n=21)**	**Δmf**		**mN (n=26)**	**ΔCN**		**mC (n=40)**
	p-value	mean ± SD	rel. diff.	p-value	mean ± SD	rel. diff.	p-value	mean ± SD
PME	0,062	2,32 ± 0,31	-9%	0,151	2,10 ± 0,39	-1%	0.986	2,09 ± 0,40
Pi	0,643	0,84 ± 0,16	-5%	0,799	0,80 ± 0,16	-2%	0.976	0,78 ± 0,25
PDE	0,610	2,63 ± 0,40	-1%	0,976	2,60 ± 0,43	4%	0.943	2,70 ± 0,43
PCr	0,196	3,75 ± 0,53	-7%	0,335	3,50 ± 0,51	-1%	0.996	3,48 ± 0,64
ATP	0,078	2,45 ± 0,43	-10%	0,313	2,21 ± 0,46	-4%	0.773	2,12 ± 0,60
NAD	–	0.39 ± 0.14	-13%	–	0.34 ± 0.10	3%	–	0.35 ± 0.10
pH	0,746	6,99 ± 0,02	0,0%	0,755	6,99 ± 0,01	0,0%	0.992	6,99 ± 0,03
Mg	0,164	0,10 ± 0,01	10%	0,560	0,11 ± 0,01	-6%	0.146	0,10 ± 0,01

r_BG		overall comparison of groups (multivariate) Statistics MANOVA: Wilks-Lambda p = 0.358						
		pairwise group comparison (post-hoc Scheffé test)						
	omnibus	**fN (n=21)**	**Δmf**		**mN (n=26)**	**ΔCN**		**mC (n=39)**
	p-value	mean ± SD	rel. diff.	p-value	mean ± SD	rel. diff.	p-value	mean ± SD
PME	0,888	2,17 ± 0,37	0%	0,995	2,16 ± 0,39	-2%	0.874	2,11 ± 0,31
Pi	0,050	0,61 ± 0,18	3%	0,982	0,63 ± 0,16	-15%	0.117	0,53 ± 0,19
PDE	0,894	2,66 ± 0,40	2%	**0,040**	2,70 ± 0,45	-2%	0.846	2,63 ± 0,42
PCr	0,287	3,48 ± 0,45	-7%	0,288	3,22 ± 0,54	2%	0.865	3,29 ± 0,53
ATP	**0,050**	2,49 ± 0,48	-5%	0,693	2,36 ± 0,40	-9%	0.233	2,15 ± 0,53
NAD	–	0.33 ± 0.10	6%	–	0.35 ± 0.11	6%	–	0.37 ± 0.10
pH	0,934	6,99 ± 0,03	0,0%	0,934	6,99 ± 0,02	0,0%	0.998	6,99 ± 0,02
Mg	0,914	0,11 ± 0,01	0%	0,946	0,11 ± 0,01	0%	0.991	0,11 ± 0,01

l_BG	overall comparison of groups (multivariate) Statistics MANOVA: Wilks-Lambda p = 0.122							
		pairwise group comparison (post-hoc Scheffé test)						
	omnibus	fN (n=21)	Δmf		mN (n=26)	ΔCN		mC (n=40)
	p-value	mean ± SD	rel. diff.	p-value	mean ± SD	rel. diff.	p-value	mean ± SD
PME	0,379	2,41 ± 0,41	-5%	0,520	2,30 ± 0,30	-1%	0.985	2,29 ± 0,34
Pi	0,397	0,72 ± 0,21	-4%	1,000	0,69 ± 0,19	-9%	0.488	0,63 ± 0,21
PDE	0,660	2,42 ± 0,39	5%	0,707	2,54 ± 0,44	-3%	0.698	2,46 ± 0,41
PCr	**0,014**	3,68 ± 0,41	5%	0,306	3,88 ± 0,53	-10%	**0.015**	3,50 ± 0,55
ATP	0,091	2,53 ± 0,47	-8%	0,315	2,32 ± 0,38	-4%	0.766	2,23 ± 0,54
NAD	–	0.33 ± 0.10	15%	–	0.38 ± 0.13	-18%	–	0.31 ± 0.10
pH	0,566	7,00 ± 0,03	0,0%	0,987	7,00 ± 0,03	-0,1%	0.710	6,99 ± 0,03
Mg	0,890	0,11 ± 0,01	0%	0,900	0,11 ± 0,02	0%	0.995	0,11 ± 0,02

r_TL	overall comparison of groups (multivariate) Statistics MANOVA: Wilks-Lambda p = **0.034**							
		pairwise group comparison (post-hoc Scheffé test)						
	omnibus	fN (n=21)	Δmf		mN (n=26)	ΔCN		mC (n=40)
	p-value	mean ± SD	rel. diff.	p-value	mean ± SD	rel. diff.	p-value	mean ± SD
PME	0,150	2,04 ± 0,39	7%	0,484	2,18 ± 0,47	5%	0.764	2,25 ± 0,38
Pi	0,277	0,59 ± 0,18	-2%	0,866	0,58 ± 0,20	-9%	0.453	0,53 ± 0,14
PDE	0,102	2,03 ± 0,54	16%	0,088	2,36 ± 0,52	-7%	0.487	2,20 ± 0,51
PCr	0,338	3,50 ± 0,63	8%	0,460	3,78 ± 0,91	0%	1,000	3,79 ± 0,71
ATP	0,138	2,30 ± 0,47	-3%	0,873	2,23 ± 0,46	-7%	0.367	2,07 ± 0,46
NAD	–	0.25 ± 0.10	28%	–	0.32 ± 0.11	6%	–	0.34 ± 0.11
pH	0,209	7,00 ± 0,03	0,0%	0,999	7,00 ± 0,03	-0,1%	0.420	6,99 ± 0,02
Mg	0,342	0,12 ± 0,02	-8%	0,688	0,11 ± 0,02	-2%	0.854	0,11 ± 0,02

l_TL	overall comparison of groups (multivariate) Statistics MANOVA: Wilks-Lambda p = 0.579							
		pairwise group comparison (post-hoc Scheffé test)						
	omnibus	fN (n=21)	Δmf		mN (n=26)	ΔCN		mC (n=40)
	p-value	mean ± SD	rel. diff.	p-value	mean ± SD	rel. diff.	p-value	mean ± SD
PME	0,526	2,13 ± 0,40	0%	1,000	2,13 ± 0,49	4%	0.631	2,23 ± 0,31
Pi	0,363	0,63 ± 0,20	6%	0,819	0,67 ± 0,26	-12%	0.366	0,59 ± 0,20
PDE	0,516	1,90 ± 0,39	4%	0,798	1,98 ± 0,38	-6%	0.518	1,86 ± 0,43
PCr	0,449	3,62 ± 0,60	8%	0,449	3,91 ± 0,81	-3%	0.792	3,78 ± 0,82
ATP	0,662	2,27 ± 0,43	-5%	0,734	2,15 ± 0,47	-3%	0.870	2,10 ± 0,52
NAD	–	0,29 ± 0,11	10%	–	0,32 ± 0,10	-9%	–	0,29 ± 0,09
pH	0,815	7,00 ± 0,03	0,0%	0,844	7,00 ± 0,03	0,0%	0.987	7,00 ± 0,03
Mg	0,903	0,11 ± 0,02	0%	0,870	0,11 ± 0,01	0%	0.976	0,11 ± 0,02

r_FWM		overall comparison of groups (multivariate) Statistics MANOVA: Wilks-Lambda p = 0.216						
		pairwise group comparison (post-hoc Scheffé test)						
	omnibus	fN (n=19)	Δmf		mN (n=25)	ΔCN		mC (n=37)
	p-value	mean ± SD	rel. diff.	p-value	mean ± SD	rel. diff.	p-value	mean ± SD
PME	0,798	2,27 ± 0,32	4%	0,751	2,35 ± 0,41	-2%	0.894	2,30 ± 0,38
Pi	0,111	0,61 ± 0,21	3%	0,982	0,63 ± 0,18	-15%	0.145	0,54 ± 0,19
PDE	0,116	2,56 ± 0,50	5%	0,797	2,69 ± 0,53	-9%	0.118	2,44 ± 0,41
PCr	0,904	3,40 ± 0,57	2%	1,000	3,46 ± 0,52	-1%	0.941	3,42 ± 0,44
ATP	**0,024**	2,60 ± 0,43	-5%	0,676	2,47 ± 0,45	-8%	0.199	2,27 ± 0,49
NAD	–	0,30 ± 0,13	17%	–	0,35 ± 0,15	-11%	–	0,31 ± 0,10
pH	0,725	6,98 ± 0,02	0,1%	0,658	6,99 ± 0,02	-0,1%	0.738	6,98 ± 0,03
Mg	0,698	0,11 ± 0,01	0%	0,899	0,11 ± 0,01	0%	0.970	0,11 ± 0,01

l_FWM		overall comparison of groups (multivariate) Statistics MANOVA: Wilks-Lambda p = 0.086						
		pairwise group comparison (post-hoc Scheffé test)						
	omnibus	fN (n=19)	Δmf		mN (n=26)	ΔCN		mC (n=38)
	p-value	mean ± SD	rel. diff.	p-value	mean ± SD	rel. diff.	p-value	mean ± SD
PME	0,931	2,22 ± 0,33	0%	0,993	2,23 ± 0,43	-2%	0.934	2,19 ± 0,34
Pi	0,198	0,66 ± 0,24	-9%	0,661	0,60 ± 0,21	-8%	0.666	0,56 ± 0,17
PDE	0,386	2,14 ± 0,51	6%	0,592	2,27 ± 0,30	1%	0.958	2,30 ± 0,36
PCr	**0,018**	3,33 ± 0,38	12%	**0,025**	3,73 ± 0,45	-7%	0.112	3,47 ± 0,52
ATP	0,058	2,35 ± 0,43	-2%	0,955	2,30 ± 0,37	-10%	0.158	2,08 ± 0,54
NAD	–	0.29 ± 0.10	6%	–	0.31 ± 0.13	3%	–	0.32 ± 0.11
pH	0,833	7,00 ± 0,04	0,0%	0,924	7,00 ± 0,03	-0,1%	0.839	7,00 ± 0,05
Mg	0,406	0,11 ± 0,02	0%	0,677	0,11 ± 0,02	-2%	0.909	0,11 ± 0,02

Absolute mean concentration values ± standard deviation of PME, Pi, PDE, PCr, ATP, NAD, and Mg are given as mmol/kg brain tissue.

Left and right half of the FGM voxel were not evaluated separately.

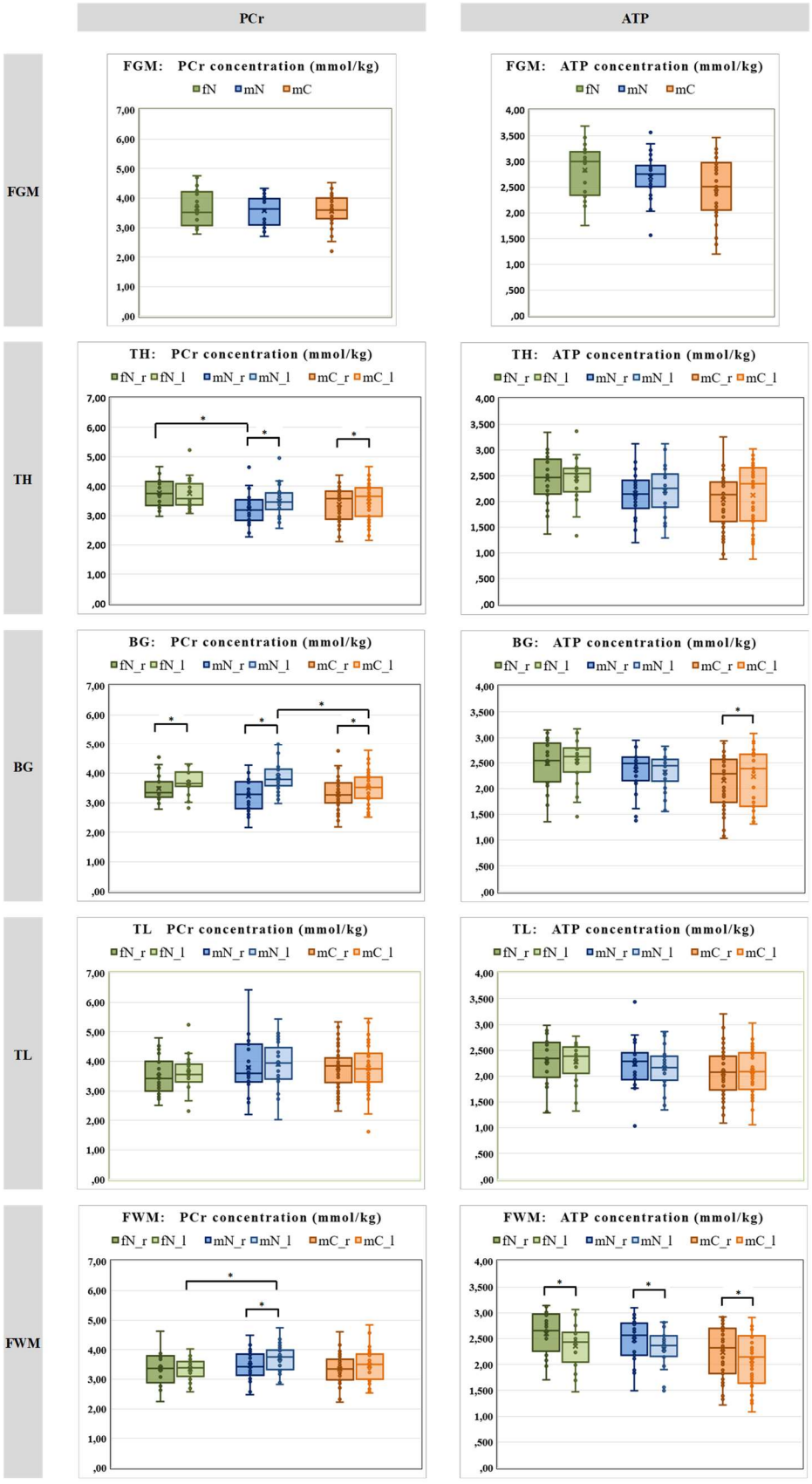
Δmf indicates the relative difference of metabolite values between fN and mN: $\Delta\mathrm{mf} = \frac{(\mathrm{mN}-\mathrm{fN})}{\mathrm{fN}}$.

ΔCN indicates the relative difference of metabolite values between mN and mC: $\Delta\mathrm{CN} = \frac{(\mathrm{mC}-\mathrm{m}\ )}{\mathrm{mN}}$.

The Wilks-Lambda test reflects the overall effect of the three groups on all seven metabolite values included in the MANOVA. NAD was excluded because of too many low-quality data. Post-hoc Scheffé test was used for paired comparison of groups.

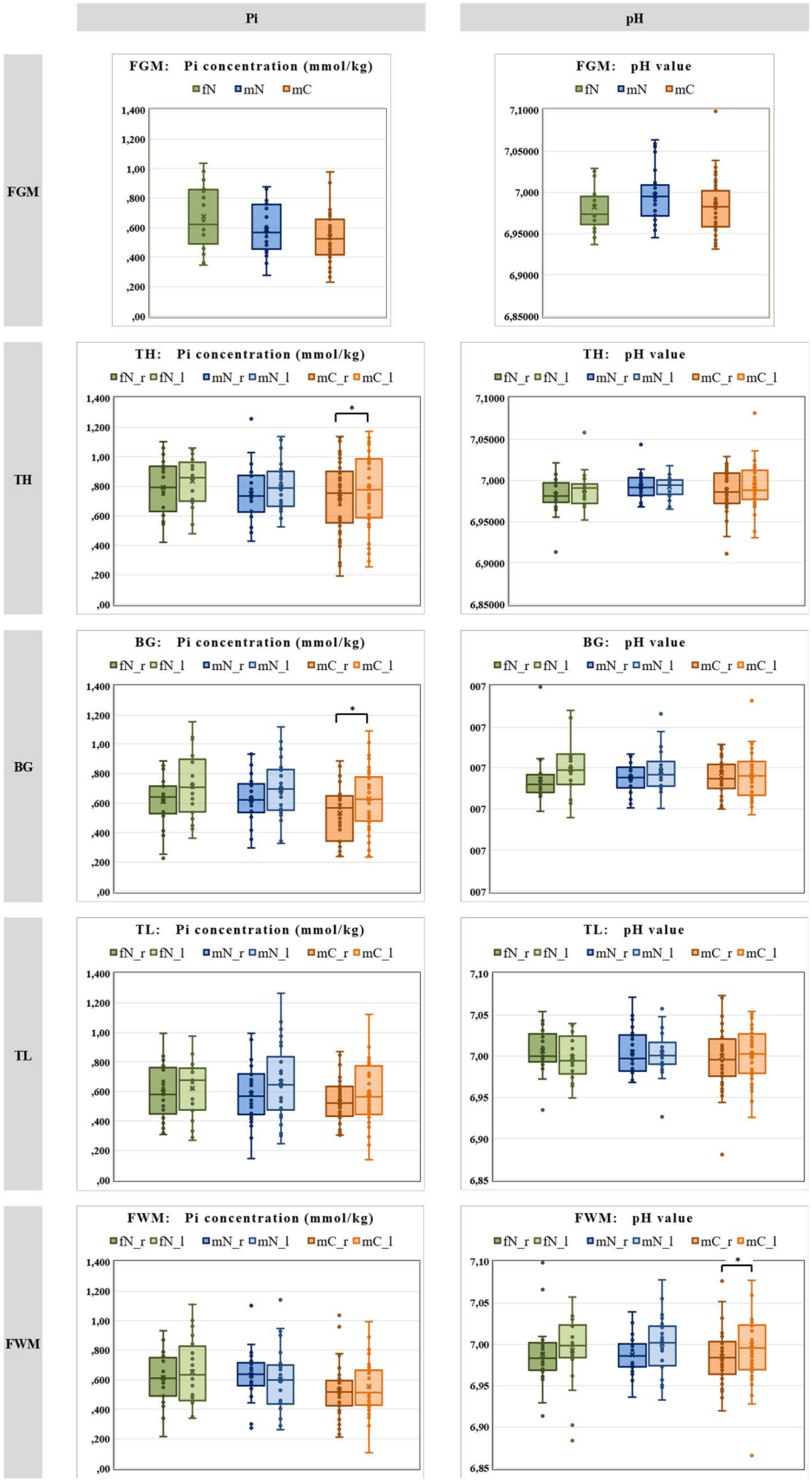
p-values < 0.05 are marked in bold. *Values that remained significant after multiple comparisons correction.

Suppl_Fig9a: Results of Phosphorus MRS: concentration values - box plot



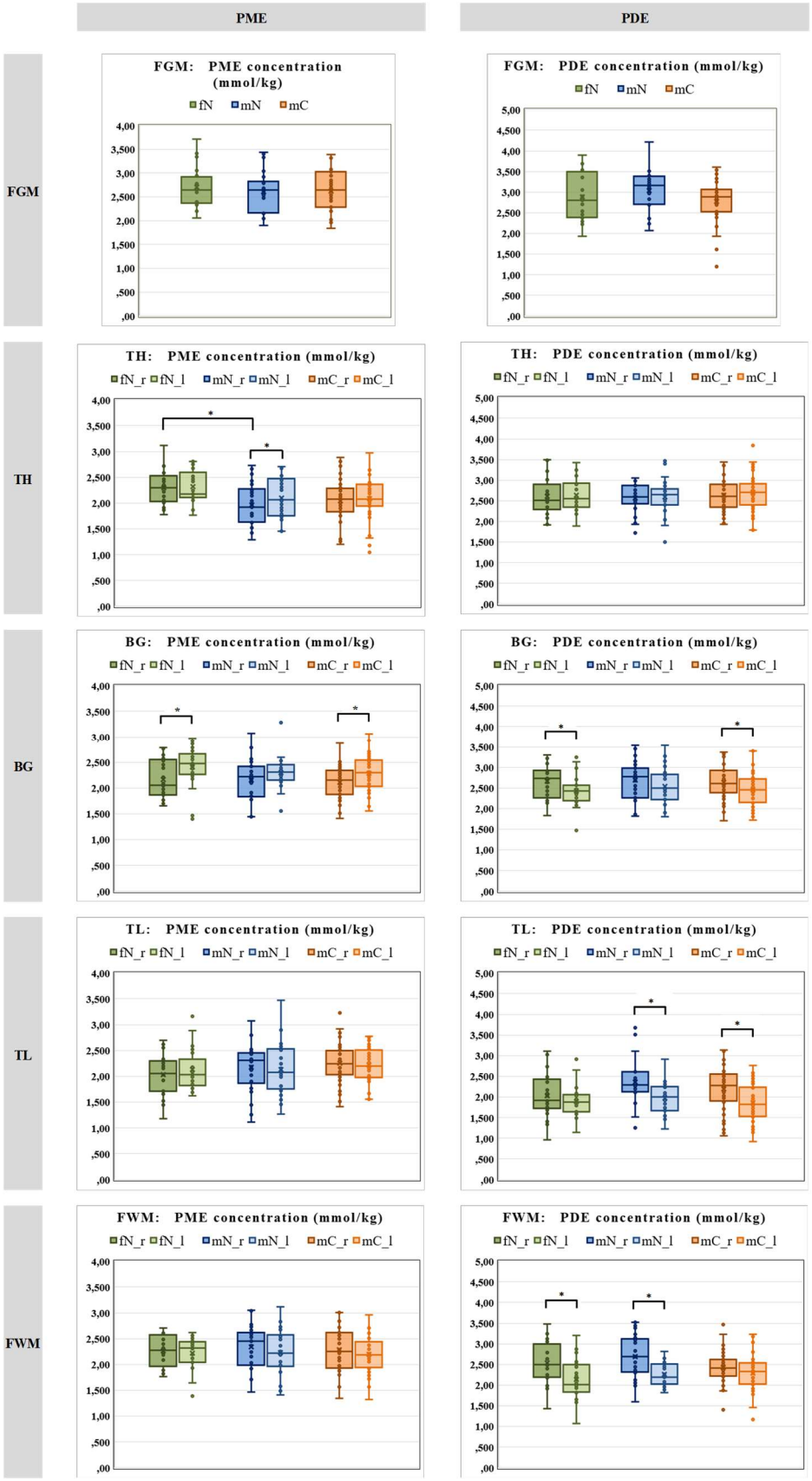
Box plots describing the variation of absolute metabolite concentration values of PCr and ATP in four different regions of the brain. Asterisk marks significant differences ($p<0.05$).

Suppl_Fig9b: Results of Phosphorus MRS: concentration values - box plot



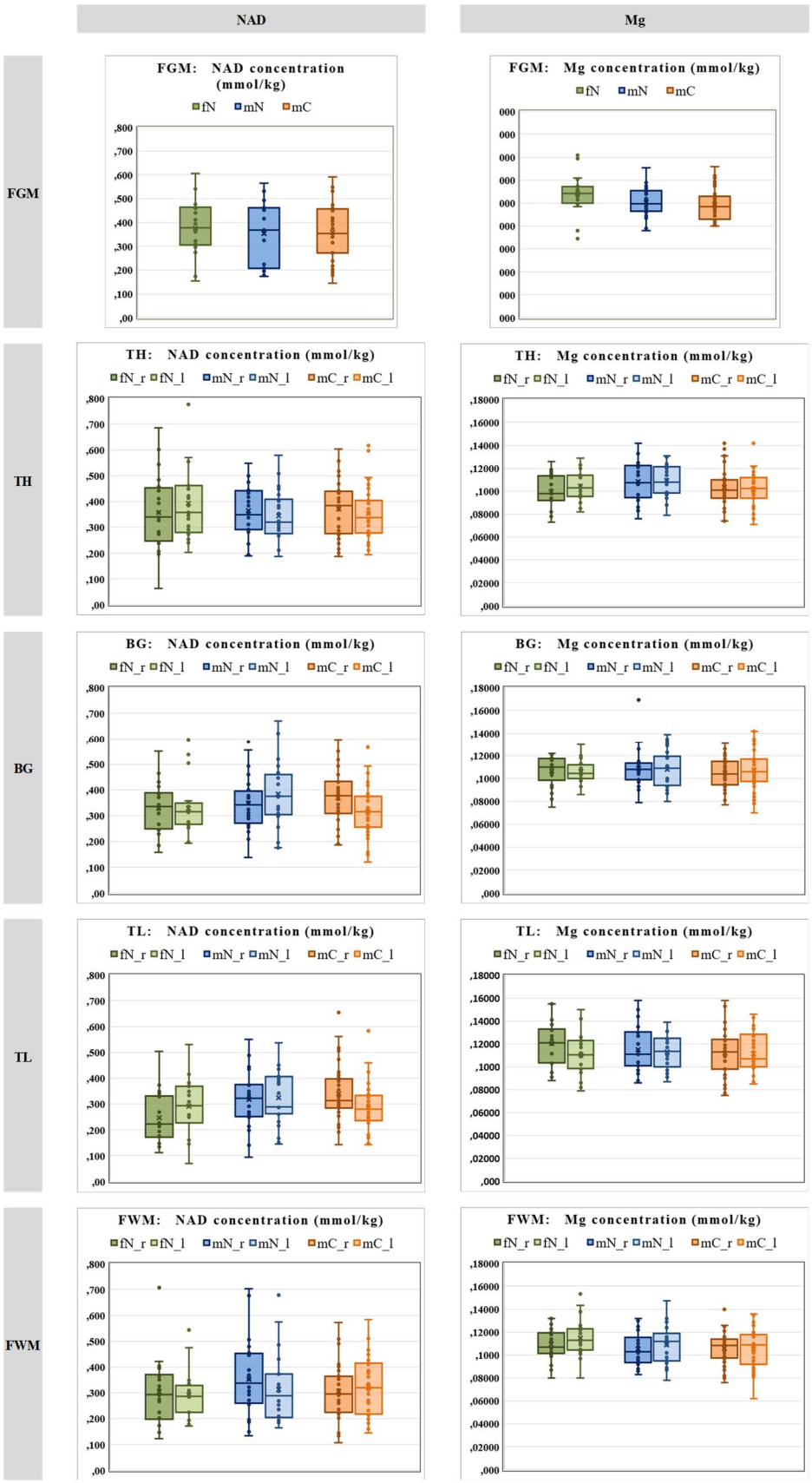
Box plots describing the variation of absolute metabolite concentration values of Pi and pH value in four different regions of the brain. Asterisk marks significant differences ($p<0.05$).

Suppl_Fig9c: Results of Phosphorus MRS: concentration values - box plot



Boxplots describing the variation of absolute metabolite concentration values of PME and PDE in four different regions of the brain. Asterisk marks significant differences ($p<0.05$).

Suppl_Fig9d: Results of Phosphorus MRS: concentration values - box plot



Boxplots describing the variation of absolute metabolite concentration values of NAD and Mg in four different regions of the brain. Asterisk marks significant differences ($p<0.05$).