FFA Evolution During Storage of Ground Roasted Coffee

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Abstract: Coffee acylglycerols hydrolysis and free fatty acids (FFA) oxidation reactions produce a FFA evolution that can affect to coffee quality during storage. The aim of this work was to study and to compare the FFA evolution of two ground roasted coffee samples: Brazilian Arabica 100% (A100) and Brazilian Arabica-India Cherry Robusta blend (A80:R20). Coffees were packaged under vacuum and stored at 25°C during 180 days. A significantly higher FFA initial concentration in A80:R20 coffee was observed. However, at 180 days, a higher increase of FFA concentration was shown in A100 sample. In conclusion, FFA oxidation seemed to be faster in A80:R20 blend than in A100.

Keywords: FFA; roasted coffee; storage; fat oxidation; staling

INTRODUCTION

During storage, roasted coffee loses the aroma and flavour of freshness due to some lipid oxidation and to the degradation of some compounds inherent to the typical aroma [1]. The coffee lipids degradation can take place by two different simultaneous mechanisms [2]: acylglycerols hydrolysis, caused by lipases and water, and oxidative reactions or autoxidation. Lipids hydrolysis releases FFA that are very prone to lipid oxidation, particularly long chain unsaturated ones [3]. Even coffee is stored under vacuum, lipid oxidation is produced, probably because of the initial presence of free radicals whose formation could be promoted by pyrolysis reactions during roasting process [4]. The aim of this work was to study and to compare the FFA evolution of two ground roasted coffee samples: Brazilian Arabica 100% (A100) and Brazilian Arabica-India Cherry Robusta blend (A80:R20).

EXPERIMENTAL

Sample preparation. Two types of green coffee: Brazilian Arabica (A100) and India cherry Robusta were roasted separately, using a precision coffee roaster (Hearthware™) at 260°C. The roasted coffees were blended to prepare Brazilian Arabica-India Cherry Robusta blend in commercial percentages (A80:R20). Coffee beans were ground to espresso grind in a M01-Azkoyen automatic grinder. Ground roasted coffee samples were packaged in trilaminated opaque bags of 250 g under vacuum, using a manual packer (Ramon Serie VP Mod.450) and stored at 25°C during 180 days.

Chemical analysis. Total lipids were extracted with chloroform and methanol (2:1 v/v) using the method of Bligh and Dyer [5]. The extraction of long chain FFA was carried out with an activated ionic resin (Amberlite A-26) following the method of Needs *et al*. [6]. Heptadecanoic acid as internal standard (IS) (Sigma-Aldrich). One μl of the final solution was injected into a capillary column SP-2560 (100 m × 0.25 mm x 0.2 μm) in a Agilent 6890 gas chromatograph. Injector temperature was 250°C, and carrier gas was helium (89.3 ml/min linear speed). The oven temperature was maintained at 165°C for 70 min, then raised at 4°C/min up to 220°C and maintained for 35 min. FID detector temperature was 250°C. Peaks were identified by comparison of their retention times with those of standard compounds (Sigma). Each FFA were quantified as mg/100 g fat. Each sample was analysed by triplicate.

Data analysis. One-way ANOVA and *T*-Tukey *a posteriori* test were applied in each coffee sample

Table 1. FFA (mg/100 g fat) evolution in ground roasted coffee samples during storage under vacuum at 25°C (mean; standard deviation)

Time (days)	0	7	15	30	60	90	120	150	180
Palmitic (C16:0)									
A100	298.8; 13.2a	537.9; 5.7c	530.5; 24.9c	558.9; 10.0cd	522.4; 29.4c	473.9; 16.7b	466.9; 10.2b	595.8; 3.0de	605.2; 21.3e
A80:R20	464.2; 6.0b	473.8; 12.4b	495.1; 16.0b	481.0; 4.4b	425.6; 21.0a	573.2; 24.1cd	598.2; 5.2d	602.3; 8.4d	554.8; 4.3c
LS	***	***	n.s.	***	**	**	***	n.s.	*
Stearic (C18:0)									
A100	53.0; 1.5a	105.5; 3.9de	112.1; 3.6e	110.7; 3.0e	96.5; 4.5c	96.1; 2.8c	78.0; 0.8b	107.1; 1.7e	99.5; 3.5cd
A80:R20	87.9; 1.2a	87.8; 2.9a	84.2; 7.3a	82.7; 1.1a	83.8; 3.3a	102.2; 2.0b	110.6; 0.5c	128.4; 1.4d	109.9; 1.1c
LS	***	**	**	***	*	*	***	***	**
Oleic (C18:1)									
A100	62.3; 2.7a	109.9; 0.8d	108.7; 2.1d	111.4; 2.6de	102.4; 5.4c	97.9; 1.6c	91.0; 1.0b	118.8; 0.2b	116.3; 2.3ef
A80:R20	100.4; 1.5b	98.0; 2.1b	101.1; 2.6b	98.1; 0.8b	90.6; 2.8a	119.3; 0.8c	123.9; 1.7c	132.2; 2.0d	124.2; 2.3c
LS	***	***	*	***	*	***	***	***	*
Linoleic (C18:2)									
A100	276.3; 14.3a	431.9; 10.6d	408.2; 9.0cd	427.2; 17.2cd	412.4; 24.0cd	371.2; 7.6b	396.2; 7.1bc	486.1; 2.9e	510.5; 4.5e
A80:R20	391.8; 4.6bc	377.7; 6.7b	408.2; 25.8c	413.9; 5.22c	339.0; 11.4a	473.0; 1.4de	463.6; 3.8de	481.5; 13.0e	450.2; 7.2d
LS	***	**	n.s.	n.s.	**	***	***	n.s.	***
Linolenic (C18:3)									
A100	7.6; 0.3b	11.0; 1.1c	10.0; 0.7c	10.0; 0.6c	10.3; 1.0c	5.4; 0.5a	10.7; 0.2c	13.0; 0.4d	14.2; 0.9d
A80:R20	8.8; 0.6ab	9.0; 0.4ab	10.3; 1.4bc	10.1; 0.2bc	8.2; 0.6a	11.8; 0.1c	10.7; 0.4c	11.5; 0.8c	11.8; 0.0c
LS	*	*	n.s.	n.s.	*	***	n.s.	n.s.	*
Arachidic (C20:0)									
A100	25.5; 0.9a	52.9; 3.0de	58.7; 0.8f	56.9; 2.8ef	45.3; 2.9c	48.5; 1.5cd	35.1; 1.5b	51.8; 2.1de	43.9; 2.0c
A80:R20	42.0; 4.1ab	42.6; 1.0ab	36.2; 3.0a	38.0; 1.7a	42.6; 5.6ab	49.4; 1.5bc	53.6; 1.7cd	71.1; 3.5e	59.6; 2.0d
LS	**	**	***	***	n.s.	n.s.	***	***	***
Behenic (C22:0)									
A100	6.6; 0.5a	15.1; 0.8de	16.2; 0.8e	16.2; 0.9e	11.5; 0.9c	14.5; 1.0de	8.7; 0.7b	14.1; 0.4d	11.0; 0.3c
A80:R20	12.5; 1.4cd	11.0; 0.6bc	8.3; 0.8a	10.2; 0.4ab	13.0; 0.3cd	13.8; 0.9de	14.1; 0.5de	21.3; 1.7f	15.7; 0.1e
LS	**	**	***	***	n.s.	n.s.	***	**	***
Total FFA									
A100	730.2; 31.7a	1264.8; 0.8c	1244.3; 36.4cd	1291; 36.8d	1201.2; 67.5c	1108.0; 23.3b	1086.7; 15.4b	1387.6; 0.9e	1402.0; 34.5e
A80:R20	1108.5; 11.3b	1101.3; 24.7b	1144.8; 2.4c	1133.0; 13.3bc	1002.7; 5.2a	1343.5; 20.1de	1375.5; 8.4e	1448.7; 12.1f	1327.8; 16.2d
LS	***	**	*	**	*	***	***	***	*

LS = level of signification between two types of coffee; n.s. = no significant ($P > 0.05$); *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

In each file, different superscripts indicate significant differences ($P < 0.05$) among different times

along the time. *t*-Student was applied between coffee samples in each time. SPSS v.9.0 software package was used.

RESULTS AND DISCUSSION

A significantly higher total FFA initial concentration in A80:R20 coffee was observed (1100 mg/100 g fat in A80:R20 vs. 700 mg/100 g fat in A100) (Table 1). Similar results were obtained by Schlüter [7]. These differences were higher for the most abundant fatty acids: C16:0 and C18:2, and C18:0 and C18:1 (in moderate concentrations).

During the first week a significant increase in all FFA, mainly in saturated fatty acids (SFA), was observed in A100, exceeding the A80:R20 FFA amount up to 90 days (Table 1, Figure 1). After 15 days, a FFA progressive decrease was observed, maybe due to FFA oxidation predominance [8], up to 60 days in A80:R20 and 120 days in A100. At these storage times, acylglycerols hydrolysis seems to be predominant, increasing FFA to their maximum level. But, in A80:R20 after 150 days, a new progressive decrease was observed. In conclusion, except for the first week, similar patterns were shown in both coffees, but FFA oxidation seemed to be faster in A80:R20 blend than in A100.

At the end of the storage, 180 days, a higher increase of every FFA was shown in A100 than in A80:R20. In A100, the FFA increase percentage during 180 days in relation to initial FFA amount was ranged between 166.4% for C18:3 and 202.6% for C16:0, whereas in the A80:R20 was ranged between 114.9% for C18:2 to 142.7% for C20:0 (Figure 2).

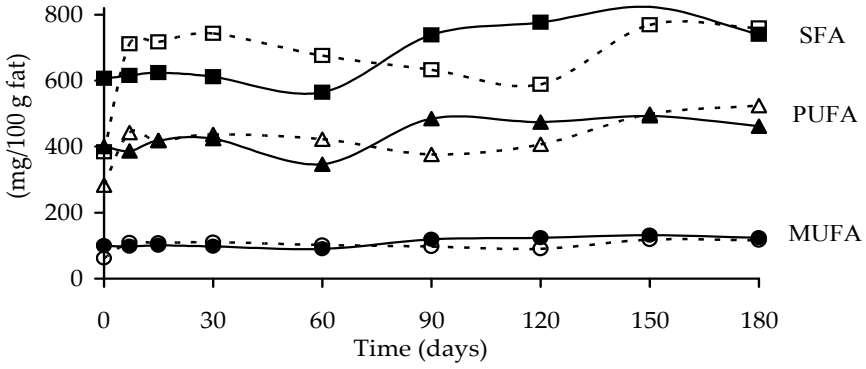

Figure 1. FFA evolution in ground roasted samples during storage under vacuum at 25°C. A100 (dotted line, empty symbols) and A80:R20 (solid line, full symbols). SFA (ν) MUFA (λ) and PUFA (σ)

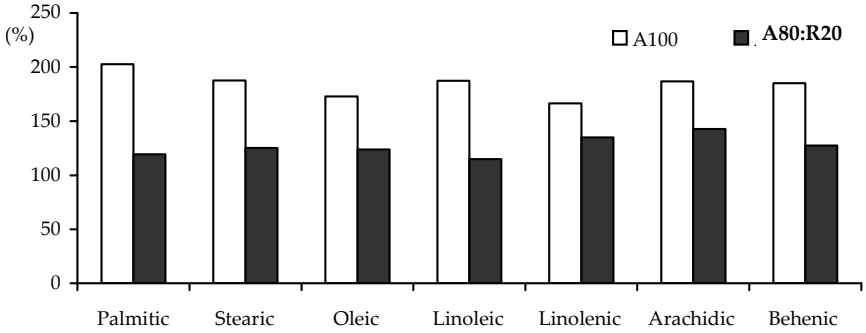

Figure 2. FFA increase percentage during 180 days in relation to initial concentration FFA

CONCLUSIONS

A significantly higher FFA initial concentration in A80:R20 coffee was observed. However, at 180 days, a higher increase of FFA concentration was shown in A100 sample. In conclusion, except for the first week, similar patterns were shown in both coffees, but FFA oxidation seemed to be faster in A80:R20 blend than in A100.

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