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QUALITY OF THE PULPED CHERRY COFFEE SUBJECTED TO CONTINUOUS AND INTERMITTENT DRYING

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ABSTRACT This study was carried out to evaluate the quality of the pulped cherry coffee submitted to continuous and intermittent drying in a fixed-layer dryer. The appraised qualitative indicators were the sensorial analysis (cup test) and chemical (total titrable acidity, polyphenols, reducing and non-reducing and total sugars, potassium lixiviation and electric conductivity). The treatments were continuous drying (without rest period) and intermittent drying (drying for 12 hours and rest period for 12 hours), by revolving the grain mass every 3 hours. The treatment with intermittent drying had a 52.63% longer total drying time when compared to continuous drying. Concerning the effective drying period, the treatment with intermittent drying showed a reduction of 24.56 % in number of hours, comparative to continuous drying. Both sensorial and chemical analyses of the pulped cherry coffee dried in fixed layer, continuous or intermittently operated, showed no differences in the quality of the coffee. Thus, the coffee grower can choose the best option for coffee drying, as a function of labor availability and operational costs.

Keywords: *Coffea arabica*, post-harvesting, quality control.

INTRODUCTION The coffee quality study concerning to its several physiochemical and chemical constituents that are responsible for the characteristic flavor and aroma of the beverage has been carried out by several researchers (Favarin et al., 2004; Malta et al., 2003). Independent of the way how coffee is dried, some cares must be been taken in order to avoid the occurrence of fermentations before and during the drying process, as well as to avoid excessively high temperatures in the mass of grains, and try to obtain lots and grains showing uniform coloration, size and specific mass after drying is completed (Lacerda Filho & Silva, 2006).

Concerning to models of the dryers available to coffee growers, Vilela (1997) mentions the most used ones to be either vertical flow and the crossed flow with resting chamber;

the rotative cylindrical ones, and the fixed-layer ones (fixed bed). The fixed-layer dryers can be operated either under continuous way or intermittent one (with resting periods).

During the fixed-layer drying process, the revolving of the coffee is recommended at regular, 3-hour time intervals because this procedure rather reduces the moisture gradients in the grain mass. Concerning to the height of the coffee layer, it can vary from few centimeters to 0.50m thickness. A height above 0.50m can cause problems, such as the high moisture gradient (Silva et al., 2000). The air temperature at 50ºC is recommended for drying. According to IBC, mentioned by Vilela (1997), the temperature must be controlled for not surpassing 45ºC in the coffee mass, in order causing no damage to the quality of the product. The practice of the resting period during the drying process is used for drying in yards because the lacked solar radiation as well as in fixed-layer drying, because the convenience of the labor available in the rural properties. However, further studies concerning to the effect of the resting period upon changes in the quality and chemical composition of the coffee are needed.

The present work was conducted to evaluate the quality of the pulped cherry coffee subjected to continuous (without rest period) and intermittent drying (with rest period) at fixed-layer dryers, as using the sensorial analysis (cupping) and chemical analysis as the qualitative indicators under evaluation.

METHODOLOGY Two drying tests were performed, as been evaluated the treatment and the control in each one. The first test, with application of the treatment 1 (SC), was accomplished with continuous drying, grain layer height of 0.40m, drying air temperature of 50 ºC and revolving period at each 3 hours, with three replicates, besides control 1 (drying on suspended yard), so totaling 6 plots. The second test, with application of the treatment 2 (SI), was performed with intermittent drying, resting period of 12 hours, drying period of 12 hours, grain layer height of 0.40 m, drying air temperature at 50 ºC and revolving period at each 3 hours (during the drying process), with three replicates, besides the control 2 (drying on suspended yard), so totaling 6 plots.

The dryer was composed by an axial fan, the ambient air heater (operated by electrical resistance), plenum and three drying chambers (metallic cylinders with perforated-foil bottom). In the local where the dryer was, the temperature and the relative humidity of the ambient air were monitored during the accomplishment of the tests, by using a digital thermal hygrometer. The temperature of the drying air (plenum-located sensor) was measured at 3-hour intervals (except for the resting period), through the type-t thermocouples (copper-constantan) connected to digital thermometer.

The controls were dried on suspended and wood-made yards from which the polyethylene screen bottom was 0.90m high. They were covered with plastic canvas and exposed to solar radiation during the day and night. The determination of the moisture was performed according to the Regras para Análise de Sementes (Brazil, 1992). Three subsamples of each experimental plot were separated for determination of the moisture by the chamber drying method at 105±3ºC for 24 hours. The moisture was determined at the beginning and the end of the drying process (after 12-hours rest) at 7 and 45 days under storage. For tests 1 and 2, the determination of the coffee moisture during the drying process was accomplished, by using two plastic-meshed sachets with initial grain mass already known, that were inserted in each drying chamber. During the drying process, the mass of each sachet was quantified at each 3-hour intervals, except for the resting period. So, the moisture of the coffee cherry mass was determined.

After drying, the coffee samples were separately stored in jute sacks at dry and airy place. At 45 days under storage, the samples were subjected to sensorial analysis (cupping), that was performed by professionals. For the accomplishment of the chemical composition analysis, the samples were taken to the Laboratório de Qualidade do Café "Dr. Alcides Carvalho", pertaining to the Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG), located at the Centro Regional de Pesquisa do Sul de Minas – Lavras. The following analyses were accomplished: total titrable acidity, potassium leaching, electric conductivity, reducing sugars, non-reducing sugars, total sugars, and polyphenols.

For chemical analysis of the coffee samples, the entirely randomized experimental design was used. The analysis of the data was accomplished, by using the variance analysis at 5% probability level. First, the variance analysis of the control was accomplished. Based on this analysis, it was verified if the contrasts between the averages of the controls were statistically null (controls statistically equal) or if there was at least a contrast between the averages. In case the contrasts were null, only one control composed by the average of both controls would be used, and such a control would be compared with the treatments. Otherwise, each control would be compared with its respective treatment.

RESULTS AND DISCUSSION The average values obtained after the end of the drying process are presented in Table 1. According to the results, the values obtained for the initial and final moisture of the coffee are according to Bartholo & Guimarães (1997). Those authors found that the moisture shown by the coffee is for cherry type and at the range 45-55 and 50-55% w.b. after pulped, respectively. Concerning to the moisture of the coffee for processing and storage (pulped already processed) after the drying, they mention the values 10-12 and 12-13% w.b., respectively.

Concerning to the total drying time for the treatments, the intermittent drying required higher hour numbers to complete drying (about 52.63% more), which can implicate a higher total cost of the drying. This occurs because the dryers represent significant values in the drying cost, and because they remain unused during part of the time (when the product was subjected to rest for 12 hours) their annual drying capacity is reduced. In relation to the effective drying period, a reduction around 24.56% was observed in the number of hours necessary to complete drying, when using the intermittent drying, comparative to the continuous one.

The shorter effective drying period could be explain by migration of the moisture occurring from the center to periphery of the grain during the resting period, as mentioned by Silva et al. (2000). This fact makes the necessary energy required by drying to be lower. However, the lowest energy consumption does not necessarily involves lower drying cost. This occurs because besides the cost of the used fuel, other factors are also considered in the drying cost, such as the operational cost of the fan and the fixed cost of the system (which includes the labor costs and the equipment depreciations) (Young & Dickens, 1975).

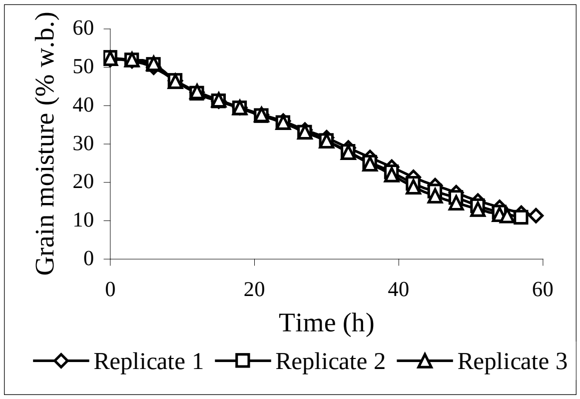
Table 1. Average values of the analyzed variables, for the treatments and their respective controls [1]

Analyzed variables		Continuous drying		Intermittent drying	
		Cont.	Treat.	Cont.	Treat.
1) Of the product	Initial moisture, % w.b.	52,41	52,28	51,48	50,84
	Final moisture (after 12h), % w.b.	10,48	10,83	11,09	10,69
	Final moisture (at 7 days), % w.b.	11,18	11,43	11,60	11,53
	Final moisture (at 45 days), % w.b.	12,80	12,86	12,85	12,63
	Initial mass, kg	12,10	34,70	12,10	34,20
	Final mass, kg	6,60	17,80	6,40	17,63
2) Of the air	Drying temperature, ^{o}C	-----	50,36	----	50,80
	Ambient temperature, ^{o}C	19,74	19,17	20,01	19,61
	Relative air humidity, %	61,34	71,91	57,31	69,33
3) Of the dryer	Air rate, $m^3.min^{-1}$	-----	10,85	----	11,12
	Air flow, $m^3.min^{-1}.m^{-2}$	-----	30,28	----	31,03
	Layer thickness, m	0,03	0,40	0,03	0,40
	Drying area, m^2	-----	0,36	----	0,36
4) Of the performance	Total drying time[(2)], h	10,0 d	57,0 h	9,0 d	87,0 h
	Effective drying period[(3)], h	-----	57,00	-----	42,67
	Moisture reduction, % w.b.	41,93	41,45	40,39	40,15

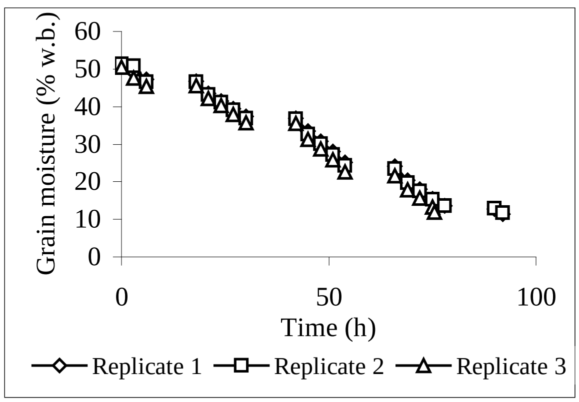
[(1)] Cont: Control; Treat: Treatment; w.b.: wet basis; (2) characterizes the total time necessary for drying the cherry coffee; (3) characterizes the time during which the coffee was subjected to the drying air; ------: data not shown.

Concerning to the data of the exhaustion air temperature, it is observed that the average for the treatment with intermittent drying data indicated a slightly lower value and higher standard deviation, compared to continuous drying. Those results were characterized by the fact that the temperature of the cherry coffee mass was reduced as a function of the resting period, during the intermittent drying. Therefore, this requires the consumption of energy to heating this grain mass again, when restarting the drying process. Lacerda Filho & Silva (2001) attributed the high energy consumption t the need for heating this mass again, which suffered the cooling because the rest for 12 hours, when promoting the intermittent drying of the cherry coffee in a concurrent -flow dryer.

The drying curves for the tests with SC (continuous drying) and SI (intermittent drying) are shown in Figure 1.



(a)



(b)

Figure 1. Drying curves of the coffee cherry in the treatments (a) continuous drying (SC) and (b) intermittent drying (SI), in which the white space in the test (b) represents the resting period.

The results of the sensorial analysis accomplished by qualified taster are shown in Table 2. Based on the results, the note attributed to the beverage showed no expressive differences as a function of the applied treatments, since both treatments provided soft and softish beverage. Borem & Reinato (2006) report that the results concerning to sensorial quality of the pulped coffee, that was dried on different yard types and in horizontal rotative dryers, show the mechanical drying to endanger the quality of the beverage.

Table 2. Results of the sensorial analysis as a function of the note attributed by the taster [1]

Evaluation	Note	Evaluation	Note
Control 1	80 (M) 78 (AM) 78 (AM)	Control 2	78 (AM) 79 (AM) 78 (AM)
Treatment 1 (SC)	80 (M) 80 (M) 77 (AM)	Treatment 2 (SI)	81 (M) 82 (M) 79 (AM)

[1](M): soft beverage; (AM): softish beverage.

According to the result obtained from the variance analysis of the controls, no significant differences occurred between the controls chemically analyzed. So, the results of the controls were unified, therefore obtaining just one control with three replicates.

A new variance analysis was accomplished in order to verify the occurrence or nonoccurrence of contrast between the control (unified) and those two treatments (Table 3). The results showed no significant differences to occur, according to the chemical analyses accomplished in either treatments and the control under analysis.

According to Borem & Reinato (2006), the chemical quality of the pulped coffee dried either on different yard types and in horizontal rotary dryers rather indicates better results for the electric conductivity, potassium leaching, reducer and no-reducer total sugar for drying on yards. In relation to the titrable acidity and polyphenols, however, the results showed no statistical differences.

Table 3. Average values of the chemical analyses for potassium leaching, electric conductivity, total titrable acidity, polyphenols, reducing sugars, non-reducing sugars and total sugars[1]

Evaluation	LK	CE	ATT	Polif.	AR	ANR	AT
Unified control	24,42a	85,11a	214a	6,00a	0,80a	7,80a	9,16a
Treatment 1 (SC)	23,10a	84,13a	217a	6,01a	0,79a	8,65a	9,90a
Treatment 2 (SI)	23,52a	87,16a	212a	6,13a	0,66a	8,76a	9,89a
CV(%)	4,89	9,59	5,76	4,49	23,11	10,37	7,89

[(1)] Averages followed by the same letter do not differ among each others at 5 % probability by “F” test; CV = variation coefficient (%); LK = potassium leaching (ppm/g); CE = electric conductivity (µScm-1/g); ATT = total titrable acidity (mL NaOH 0,1N/100g); Polif. = polyphenols (%); AR = reducing sugars (%); ANR = non-reducing sugars (%); AT = total sugars (%).

CONCLUSION According to the results of the chemical analysis (potassium leaching, electric conductivity, total titrable acidity, polyphenols, reducing sugars, no-reducing sugars and total sugars) there is no statistical differences in quality of the coffee dried in continuous and intermittent way. Taking into account that the continuous and intermittent drying (with resting period up to 12 hours) did not interfere into quality of the pulped cherry coffee that was dried in fixed layer, the coffee grower can decide about the better drying option as a function of the labor availability and its operational costs.

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