

## Content and Formation of Acrylamide in Traditional Coffee Roast Programmes

Tongyu Xu<sup>1,2,3a</sup>, Chunliang Yang<sup>2,3b</sup>, Shaodong Zeng<sup>2,3c</sup>, Mingyue Wang<sup>2,3d</sup>

<sup>1</sup>College of Food Science & Technology, Huazhong Agricultural University, Wuhan 430070, China

<sup>2</sup>Agricultural Products Processing Research Institute, Chinese Academy of Tropical Agricultural Sciences, Zhanjiang 524001, China

<sup>3</sup>Laboratory of Quality and Safety Risk Assessment on Agro-products Processing of Ministry of Agriculture, Zhanjiang 524001, China

<sup>a</sup>xutongyu2014@163.com, <sup>b</sup>zjyangcl@yahoo.com.cn, <sup>c</sup>shaodongzeng@163.com,  
<sup>d</sup>hkwmy0815@163.com

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**Abstract.** Since the taste, aroma, colour of coffee were the main indicators of traditional coffee roast programme, the content of acrylamide was defined as final standard in this paper. The least content of acrylamide produced in coffee roast process was picked out, and the formation rule of acrylamide was also explored. The results indicated that after roast programme one, the content of acrylamide was the least. The relevant process condition was as followings: when the input temperature was 205 °C and the output temperature was 210 °C, the content of acrylamide at last was 117 ng/g, the rate of weight loss was 17.5%. The content of acrylamide in the whole programme increased at first but decreased near by the first burst (about 186 °C) until finished. To reduce the content of acrylamide in roast programme, measures should taken such as shorten the time before the first burst and prolonged the heating time after that appropriately to ensure further evaporation of acrylamid. The results provide theoretical basis and experience reference for reducing the content of acrylamide in roasted coffee.

### Introduction

Acrylamide is divided into a 2A class carcinogen by international agency for research on cancer (IARC, 1994), namely human possibly carcinogenic substance [1]. A large number of animal poison rational tests showed that acrylamide produced nerve toxicity, genetic toxicity and carcinogenicity to animals which influence the health of human beings latently [2,3,4]. In 2002, people found that acrylamide were detected in coffee and frying and baking foods which were rich in starch (such as French fries, French Fried potatoes, cereals and bread, etc.) [5].

The coffee will produce a certain amount of acrylamide during roast process. Coffee contain a certain amount of acrylamide may have a bad influence both on the health of consumers and the development of the coffee industry [6]. In our study we affirmed the content of acrylamide as the primary testing index, and researched three kinds of traditional roasted coffee to find which process produced least content of acrylamide and summarize the formation rule of it.

### Material and methods

**Coffee beans.** Robusta green coffees and roast coffee beans origin in Wanning in Hainan Province of China, which were taken from from Hainan Fushan Coffee Vocational Training School.

**Equipment and Reagents.** ACQUITY UPLC-TQD (Waters), MS; Baking oven ( half hot - air furnace, Taiwan canvas ).

## Coffee roasting programmes.

Pick coffee beans → drying → roasting → cooling → Bagging

Roasting programmes essentials : Fushan coffee roasting programme was used, its features: sugar and spice was not added in process, 100% pure coffee; putting 600g coffee beans into each stove; simulated stir-fry lasted for 15 min; after beans were inputted into stove after 1 minutes and 30 seconds, return the temperature back.

## Results and discussion

The Robusta green coffee beans were roasted under three kinds of traditional programmes. Temperature and time curves of three kinds of traditional programmes.(Figure 1).Color of coffee beans of three kinds of roasted programmes(Table 1).

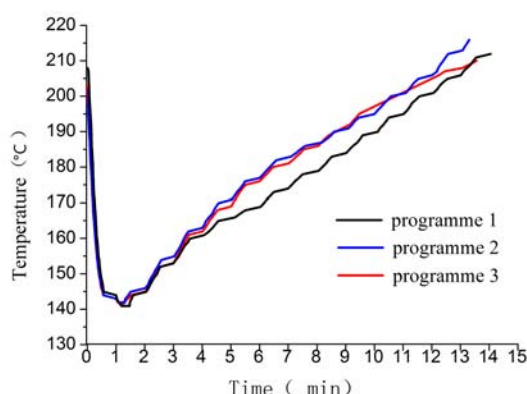


Fig. 1 Temperature and time curves of three kinds of traditional roast programmes

Programme one(Pro. one):205-210°C. The roasting fire arrangements: input stove 205°C to 150°C, big fire; 150°C to 165°C, middle fire; 165°C to 195°C,big fire; 195°C to 210°C,middle fire. Acrylamide final content was 117 ng/g. The weigh lost was 17.5%. After coffee beans were inputted into stove, the temperature returned after 1 minutes and 30 seconds, when the temperature reaching 150-155°C after that, the dampers were open thoroughly for removing skin. The dehydration stage was before 150°C and the caramelization began at 160°C. With the coming of first burst of coffee beans about at 186°C(the following abbreviation “the first burst”), reducing firepower at 192°C may decilne the formation of bitter substances effectively.

Programme two(Pro. two): 200-215°C. The roasting fire arrangements: after beans were inputted into stove between 200°C and 168°C, big fire was used, between 168°C and 185°C, middle fire was used, between 185°C and 205°C,big fire was used, between 205°C and 215°C, middle fire was used. The final content of acrylamide was 193 ng/g while the weigh lost was 17.6%.

Programme three(Pro. three): 200-210°C. The roasting fire arrangements: after beans were inputted into stove between 200°C and 170°C, big fire was used, between 170°C and 186°C, middle fire was used; between 186°C and 205°C,big fire was used, between 205°C and 210°C, middle fire was used. The final content of acrylamide was 136 ng/g while the weigh lost was 18.5%.

Three kinds of programme curves were shown in Figure 1(fig.1). We could see from fig.1, when roast temperature was 160°C, and the roast time was 4 min and there are significant difference between each roast process curve. The roast process curve of Pro. one was below the temperature returning point, and the heating rate was lower than process two and three. The content of acrylamide of Pro. one was lower than others indicated that when the later rate of temperature rising was lower, the content of acrylamide was smaller.

Table 1 The relationship between final content of acrylamide and three roasting programmes

Roasting programmes	Process of Roasting programmes										Acrylamide(ng/g)
NO.1: 205-210℃	Firepower	Big fire			Middle fire		Big fire		Middle fire		117
	Temper(℃)	205	139	150	150	165	165	195	195	210	
	Time(min)	0:00	1:19	2:53	2:54	5:32	5:33	11:23	11:24	14:05	
	Total Time(min)	2:53			2:36		5:50		2:41		
NO.2: 200-215℃	Temper(℃)	200	140	168	168	185	185	205	205	215	193
	Time(min)	0:00	1:09	5:00	5:01	8:17	8:18	12:18	12:19	13:30	
	Total Time(min)	5:00			3:16		4:00		1:12		
NO.3: 200-210℃	Temper(℃)	200	142	170	170	186	186	205	205	210	136
	Time(min)	0:00	1:29	5:11	5:12	8:09	8:10	12:25	12:26	13:59	
	Total Time(min)	5:11			2:57		4:15		1:34		

Compared with different roast process in Table 1, the total time of the first and second stage of Pro. one was shorter than that of Pro. two and Pro. three, and the final content of acrylamide of Pro. one was lower than that others. The total time of the first two stages of Pro. three was shorter than that of Pro. two, meanwhile the final content of acrylamide of Pro. three was lower than that of Pro. two. The results showed that, shortening the time of the first and second stage may help to reduce the final content of acrylamide. This may result from the time of the first two stages was really short which declined the content of acrylamide. Compared with Pro. two and Pro. three, the total time of the Pro. one was longer, besides, the final content of acrylamide of Pro. One was lower than other. Compared with Pro. two, the total time of later two stages of Pro. Three was longer, and the final content of acrylamide of Pro. three was lower. It can be seen from these that prolonged the total time of the third and four stage may reduce the content of acrylamide.

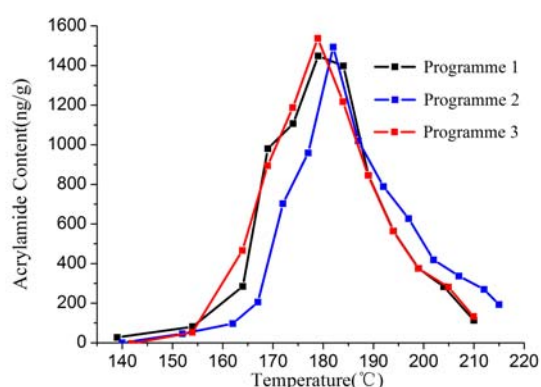


Figure 2. The content of acrylamide curve in three roasting programmes about temperature

It can be seen from Fig. 2, the content of acrylamide of three kinds of coffee roasted programmes increased firstly and then reduced, and it began to fall at the first burst (186℃), and falling until the end. It indicated that the stage between the first burst and output was the key point to reduce the content of acrylamide. The formation curve of acrylamide of Pro. one was smoother than that of Pro. two and Pro. three before first burst, the rate of forming acrylamide was slowly,

namely. The formation curve of acrylamide of Pro. two was smoother than that of Pro. one and Pro. three after first burst, the rate of forming acrylamide was slowly, namely.

The above results showed that if the heating time of the first two stages of roast programmes were reduced and later stages were increased may reduce the content of acrylamide in coffee. It is very important to control the roast time of the last stage for reducing the content of acrylamide in roast coffee.

## Conclusion

In conclusion, the content of acrylamide of Pro. one was the least in three coffee roast programmes, the main programme conditions were as followings: the input temperature was 205 °C and the output temperature was 210 °C. Besides, the final production of acrylamide was 117 ng/g and the rate of weight lose was 17.5 %. The specific datas about temperature and time of roast Pro. one are shown in Table 2.

Table2. The Roast Temperature and Time of Pro. one

Contents	Dats												
Time	0:04	1:19	1:47	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:02	10:00	11:02
	12:00	13:02	13.54	14.05									
Temperature	205	139	139	142	151	158	163	167	172	177	182	187	193
	198	204	209	210									

According to the formation rules of acrylamide in roast coffee, we could short the time before the first burst and increase the heating rate to decrease the amount of acrylamide. At the same time, time after the first burst could be prolonged and the heating rate could be decreased to promote the degradation of acrylamide. Due to the boiling point of acrylamide was 125 °C(3.33 KPa), the first burst temperature was 186 °C mean evaporation of acrylamide had happened. So prolonging the roast time may reduce the content of acrylamide in roast coffee.

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