National Exams May 2012

04-Agric-A7, Chemistry and Microbiology of Foods

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. Candidates may use one of the two calculators, the Casio or Sharp approved models. This is a closed book exam.

3. Any four (4) questions from section I and any four (4) questions from section II constitute a complete paper.

4. Marks for each question are given on the question paper. All questions in each section are of equal value.

5. Most questions require an answer in essay format. Clarity and organization of the answer are important. Be brief and to the point.

I. Food Chemistry
Do any **four** questions from this section.

1. (a) Why do roasted and fried foods taste richer and "better" than boiled or steamed foods? (4.5 marks)

(b) Hydrolyzed proteins are often added to baked/roasted products to improve the flavour. What is protein hydrolysis? Why would you expect a hydrolyzed protein to produce more flavour on roasting than a whole protein (native or denatured)? (8 marks)

2. (a) Beer is made by allowing the grains to germinate slightly (malting). The amylase enzymes are expressed and start to convert starch to glucose. After a limited amount of malting the grains are dried and roasted (kilning). Lager grains (to make light beer) are roasted to approximately 79°C and stout grains (to make dark beer) to approximately 105°C. What aspects of this are important to the Maillard reaction and the quality of the beer? (8.5 marks)

(b) To keep the potato chips crisp you want to store them at as low as low an a_w (water activity) as possible – why might you not want to store too low? (4 marks)

3. Use your knowledge of glass transition theory to briefly explain the following phenomenon. (12.5 marks)

(a) When you boil pasta it goes from brittle to soft. Why doesn't pasta soften with dry heat (in an oven) or harden on cooling after cooking?

(b) Hard candies left in a moist environment become sticky on the outside but stay crunchy in the centre.

(c) Freshly baked bread packed immediately in a plastic bag will develop a soft crust but left in an open container will develop a crispy crust. (Hint: Freshly baked bread is still steaming).

(d) Dry corn is a hard brittle material (about 14% moisture) but it will pop when heated above a critical temperature. What phase transitions are important in the formation of popcorn?

4. (a) Could you safely recommend an water activity (a_W) of 0.96 and pH 6.8 for the system of Table 1 below? Why? (6.5 marks)

Table 1: Growth of *Clostridium botulinum* type B at various levels of temperature, pH and a_W

Temp., °C	pH	a_W						
		.997	.99	.98	.97	.96	.95	.94
20	5							
	6	4*	9	9				
	7	2	2	4	9			
	8	2	2	4	14			
	9							
30	5							
	6	2	2	3	9			
	7	1	1	2	3	9	14	
	8	1	1	2	4	14		
	9							
40	5							
	6	1	2	2	3	14		
	7	1	1	1	2	3	9	17
	8	1	1	1	2	9	14	
	9							

* Incubation period in days before growth was observed.

4. (b) Do the data of Table 2 support the concept that water activity (a_W) is a better criterion for growth than moisture content? Why? (6 marks)

Table 2: The minimum a_W and moisture contents for the growth of *Staphylococcus aureus* in various media at 30°C.

Nutrient	Solute added to control a_W	Minimum a_W	Moisture content, % dry basis
Yeast extract, casamino acids, casitone	Salts mixture	0.88	375
Nutrient broth	Salts mixture	0.86	315
Nutrient broth	Sucrose	0.88	60
Nutrient broth	Salts + sucrose	0.86	75
Milk	None	0.86	16
Meat	None	0.88	23
Soup	None	0.86	63

5. The activation energy for riboflavin degradation in whole milk stored in blow-molded polyethylene (BMP) bottles under light was 49 695 kJ/kg mol. The initial concentration of riboflavin in milk is 2 mg/L. If the first order rate constant at 2□C is 16×10^{-4} per hour, calculate the riboflavin concentration in milk stored at 10□C for 72 hours in the BMP bottles. R (gas constant) is 8.314 kJ/(kg.K) (12.5 marks)

6. (a) How and why protein structure is denatured? (8 marks)
(b) Illustrate through a diagram the difference between flocculation and coalescence of emulsion droplets. (4.5 marks)

7. (a) Briefly define/explain the meaning of the following terms and provide a food example of each: (i) Tempering, (ii) Metal chelator, and (iii) Retrogradation (9 marks)
(b) In the context of protein folding, briefly explain the meaning of importance of solvent entropy. (3.5 marks)

II. Food Microbiology

Do any **four** questions from this section.

8. (a) What characteristics distinguish fungi from other organisms? In what ways are fungi beneficial, and in what ways are they harmful in foods? (7.5 marks)
(b) What benefits and hazards are associated with refrigerating foods? (5 marks)

9. (a) How do each of the following affect the potency of chemical antimicrobial agents: storage time, temperature, pH, and concentration of the chemical agent? (8 marks)
(b) How does infection differ from contamination? (4.5 marks)

10. (a) List organisms that cause food spoilage. (5 marks)
(b) List the major diseases transmitted by food, identify the causative organism(s), and explain how they enter foods. (7.5 marks)

11. (a) Compare the holding method of pasteurization, flash pasteurization, and sterilization of milk. (8 marks)
(b) How are microorganisms used as food? (4.5 marks)

12. (a) List 5 product groups of commercial interest are produced by industrial fermentations. (5 marks)
(b) Draw a flow diagram for wine production and briefly describe each unit operation in 1-2 sentences. Highlight differences between white and red wine production. (7.5 marks)

13. (a) A food sample was delivered to a laboratory to perform coliform counts. 10 g of each sample were added to 90 ml of saline. A dilution series were prepared down to 10^{-4} and 0.1 ml plated onto MAC agar (duplicate plates). After incubation at 35°C for 24 h the following counts were obtained. Calculate the cfu/g (show calculations) (7.5 marks)

Plate	10^{-2}	10^{-3}	10^{-4}
I	250	155	10
II	228	176	5

(b) What is the order in which the following foods would spoil? (5 marks)

1. Green tomato held at 15°C
2. Sirloin beef steak held at 4°C on a plate
3. Whole fish stored at 4°C on a plate
4. Deli meat at 4°C under modified atmosphere
5. Raw milk held at 4°C

14. (a) You are validating a pasteurization treatment for *Salmonella* in liquid egg and provided with the following information.
Salmonella D value at 53°C = 5 min, and Z value = 10°C
The process will involve holding the product at 65°C for 2 min prior to increasing the temperature to 70°C to complete the thermal process. The overall process must achieve an 8 log reduction in *Salmonella* numbers. Therefore, how long should the product be held at 70°C, after the initial 65°C treatment, to achieve an 8 log reduction in *Salmonella* numbers? (9 marks)

Note : D (thermal death time) = Time/(Log N_o – log N), $Z = (T_2-T_1)/(\log D_1 - \log D_2)$, where N_o is initial microbial population, N is final microbial population, D_1 is D value at temperature T_1, and D_2 is D value at temperature T_2.

(b) What is a colony forming unit (cfu)? Why this term is used instead of cell number? (3.5 marks)