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## Table of Contents

---

No.	TITLES AND AUTHEORS	Page No.
1	CULTURAL COMPETENCY AND PLURALISM IN EDUCATION Gail Beier	1
2	UNDERGRADUATE CREATIVITY AT A CHINESE UNIVERSITY: A U.S. FULBRIGHT STUDY IN PEDAGOGY Carol A. Mullen	6
3	SAFETY AND PROFITS IN THE AIRLINE INDUSTRY Ryan Broaderick, Lori Emmel, Krzysztof Gierczak, Ramon- Osvaldo Gonzalez	12
4	SHOULD AMERICA PHASE OUT CASH TO CURTAIL UNLAWFUL TRANSACTIONS? Reza Varjavand	19
5	PART-TIME TEACHERS DEVELOPING THEIR COORDINATORS Brad Deacon	26
6	A REVIEW OF SECLUSIVE PROTECTION OF CLOUD STORAGE RELATED TO STEGANOGRAPHY TECHNIQUES Pramneet Kaur, Shailendra Kulkarni	31
7	ISLAMIC FINANCE AND MORAL RESPONSIBILITY Abdulazeem Abozaid	38
8	TEACHERS' PERCEPTION OF EFFECTIVENESS ON SUBMISSION RATE OF DIGITAL VERSUS PAPER SUBMISSION OF HOMEWORK Adel Al-Bataineh, David Hallatt, Megan A. Huss, Catherine Unsbee	45
9	E-TRACKING SYSTEM FOR PUBLISHING COMPANY Kunyanuth Kularbphettong	51
10	CORPORATE GOVERNANCE AND EARNINGS MANAGEMENT PRACTICES IN PAKISTANI FIRMS Talat Afza, Mian Sajid Nazir	59

No.	TITLES AND AUTHEORS	Page No.
11	TECHNOLOGY DRIVEN FACULTY DEVELOPMENT-LESSONS FROM A CARIBBEAN UNIVERSITY (WITH SPECIFIC FOCUS ON JAMAICA) Alicia Palmer	66
12	FACTORS INFLUENCING THE OUTSOURCING OF CORE BUSINESS DELIVERABLES IN A SELECTED STATE OWNED ENTERPRISE IN SOUTH AFRICA Marcia Magagula, Robert Walter Dumisani Zondo	72
13	THE NEXT MOBILE REVOLUTION: NEAR FIELD COMMUNICATION Rajinder Gupta ,Shabnam Kaur, Manav Saini	79
14	A SYTEMS MODEL OF SUBJECTIVE CREATIVE WELLBEING: IMPLICATIONS FOR THE INDUSTRIALIZATION OF CREATIVITY Bob Shields	84
15	THE DRIVERS OF UNIVERSITY KNOWLEDGE TRANSFER TO FIRMS IN GHANA: A STRUCTURAL EQUATION MODELLING APPROACH Abdul-Fatahi Abdulai, Lyndon Murphy, Brychan Thomas	92
16	DEVELOPING AND SUSTAINING VOCATIONAL EDUCATIONAL TRAINING IN AFRICA: THE CORE ELEMENT John Olotewo	99
17	DO YEARS OF TEACHING EXPERIENCE REALLY MATTER IN FACULTY CONCEPTIONS AND MISCONCEPTIONS OF IMPLEMENTING HYBRID COURSES? Ramón-Osvaldo González,Elsa-Sofia Morote, Jeanne Radigan, Helen C. Wittman	107
18	DETERMINANTS OF MONETARY POLICY DYNAMICS IN SUB-SAHARA AFRICA: AN EMPIRICAL INVESTIGATION Andrew Maredza, Ebenezer Gbenga Olamide	114
19	EVALUATION OF DIFFERENTIATION AND ORIENTATION ABILITIES OF BASKETBALL PLAYERS AT DIFFERENT LEVELS OF COMPETITION Navdeep Singh Grewal	120

No.	TITLES AND AUTHEORS	Page No.
20	AN ASSESSMENT OF THE IMPACT OF YOUTHZONES (A COMMUNITY PROJECT) ON THE LIVES OF YOUTHS IN IMPOVERISHED COMMUNITES IN SOUTH AFRICA Michelle Ovens, Johan Prinsloo	128
21	CROSS TABULATION ANALYSIS OF DEMOGRAPHIC DETERMINANTS ON CREDIT ACCESSIBILITY FOR SMALL AND MEDIUM ENTERPRISES IN SOUTH AFRICA CONSTRUCTION INDUSTRY Olanrewaju Abdul Balogun , Ansary Nazeem	134
22	COOPERATIVE DRIVING THROUGH SOCIAL NETWORKS OF CARS Li-Mei Chen ,Chunlei Liu ,Jun Zhang	142
23	PERCEPTION OF PARENTAL INFLUENCE IN MARITAL CHOICE BY UNDERGRADUATES AT POINT OF GRADUATING Abolanle Olukemi Lasode ,Nike Elizabeth Tobi	149
24	GREEN HUMAN RESOURCE MANAGEMENT TOWARDS SUSTAINABLE ORGANIZATIONS: A CASE OF HIGHER EDUCATION INSTITUTIONS Muhammad Hoque, Vuyokazi Mtembu	155
25	TOURISM AND TOURISM AT HOME Anita Eves, Seo Yeon Jang	164
26	SIGNIFICANCE OF CANADA AS A SHELTER IN A PRAYER FOR OWEN MEANY Onur Kaya	171
27	BEROM LANGUAGE, CULTURAL BELIEFS AND MENTAL WELL-BEING: A QUALITATIVE STUDY Dung Ezekiel Jidong, Poul Rohleder, Rachel Tribe, Aneta Tunariu	179
28	EVALUATION OF THE PERFORMANCE FROM THE PERSPECTIVE OF THE TQM IN THE PUBLIC AND PRIVATE HOSPITAL Nada Hassan Abdelgadir Ahmed, Mutaz Elsayed, Mohamed Hafiz	189

No.	TITLES AND AUTHEORS	Page No.
29	THE USE OF RANDOM AMPLIFIED POLYMORPHIC DNA (RAPD) TO STUDY THE GENETIC VARIATION OF BIOSURFACTANT PRODUCING BACTERIA Okwujiakor, Nwaehiri Linda, Oge Mbanefo, Toochukwu Ogbulie, Chioma Okore	197
30	WOMEN, RELATIONS AND LOVE: NARRATIVES BY AMRITA PRITAM Mini Gill	206
31	INTERNET USAGE ON MOBILE PHONES OF UNIVERSITY STUDENTS Siriporn Poolsuwan	212
32	COMMUNITY-ENGAGED LEARNING AND CULTURAL DIVERSITY: TEACHING AND ASSESSING INTERCULTURAL COMPETENCE AND ADVANCED LANGUAGE SKILLS IN ONLINE FRENCH Marie-Anne Visoi	219
33	WOMEN'S PARTICIPATION IN AGRICULTURE ENTREPRENEURSHIP IN DEVELOPING COUNTRIES: WHAT A PITY! Evelyn Derera, Charles O'Neill, Maxwell Phiri	227
34	AN INVESTIGATION OF ERROR FEEDBACK WITH IMPROVEMENT STRATEGIES AND REFLECTION ON INTERNATIONAL STUDENTS' ACADEMIC WRITING Li-Mei Chen, Chunlei Liu	236
35	COLLABORATIVE WRITERS' PERFORMANCE, THEIR PERCEPTIONS OF THE TOOL-MEDIATED WRITING, AND COMMUNICATION RELATIONSHIPS Meng-Ying Daphne Lin	244
36	DIALOGIC LEARNING IN ONLINE ENVIRONMENTS: A CASE STUDY OF BRITISH A-LEVEL PHILOSOPHY STUDENTS Daniel Dennis	252

No.	TITLES AND AUTHEORS	Page No.
37	FOOD CONSUMPTION OF NIGERIANS AND HOW TO IMPROVE LIFE EXPECTANCY THROUGH WELL REVIEWED COOKING HABITS O.F. Mike-Rowland	260
38	PROFESSIONAL PREPARATION THROUGH INTERDISCIPLINARY COLLABORATIVE PROJECTS Lorrie Frear	270
39	TEACHING COMPETENCIES OF THE SECONDARY STUDENT-TEACHERS OF DMMMSU Remedios Neroza, Nona Rivera	279
40	THE EFFECTIVENESS OF MOTHERS-TRAINING PROGRAM ON CHILDREN WITH LEARNING DISABILITIES Nadia Tazi	287
41	COMPARATIVE EVALUATION OF ANTI-ALZHEIMER POTENTIAL OF SOME COMMONLY USED PLANTS AND MUSHROOM SPECIES Ravinder Kaur, Richa Shri	295
42	COMPARATIVE STUDY OF SOIL WASHING OF LEAD, ZINC AND COPPER USING BIOSURFACTANT AND SOME SOIL WASHING AGENTS Okwujiakor, Agunna Ejele, Nwaehiri Linda, Oge Mbanefo, Toochukwu Ogbulie, Chioma Okore	302
43	EFFECTS OF CORN COB FIBER ADDITION ON NOODLE PROPERTIES Nuntaporn Aukkanit , Supawan Pantong , Phikunthong Sawatwong, Jannapa Yeela	310
44	ENERGY MANAGEMENT OF REAL-TIME WIRELESS POWER TRANSMISSION PROTOTYPING A MICROSCOPIC TO MACROSCOPIC APPROACH Imtiaz Hakeem, Salimu Rehman, Abdul Waseem	318

No.	TITLES AND AUTHEORS	Page No.
45	KNOWLEDGE ACQUISITION BY SELF-LEARNING METHODS WITH STRUCTURED CLINICAL DATA  Joachim Baumeister , Sebastian Furth ,Daniel Knöll , Klaus Peter Scherer	327
46	RECOMMENDATION SYSTEM FOR VISITING WEBSITES  Assem A. Alsawy ,Ahmed M. Omran	334
47	CHILD IS MEANT TO LEARN NOT TO EARN: LITERATURE REVIEW ON CONTENDING CHILD LABOUR ISSUES AND CHALLENGES  Aswin George , Sarmistha Nandy	341
78	FEMALE BODY AS A NARRATIVE: A CRITICAL STUDY OF JAMAICA KINCAID'S LUCY  Maham Latif	350
49	FEMALE BODY AS A NARRATIVE: A CRITICAL STUDY OF JAMAICA KINCAID'S LUCY  Maham Latif	359
50	THE CONFLICT BETWEEN IDEOLOGICAL CONSTRAINTS AND UTOPIAN IMPULSES IN GO TELL THE SPARTANS  Tajaddin Salahaddin Noori	369
51	STORYTELLING IN MULTIDISCIPLINARY CONFERENCES  J. Bonnici, Henry Greene	377
52	GROUP PROCESS SOLVES THE PROBLEMS IN LEARNING THE CONCEPT OF HAZARD ANALYSIS  Jaruwan Chutrtong	386
53	CONVERSION OF THE EARTH/CONSTRUCTION OF THE TECHNOSPHERE: AN ENVIRONMENTAL ISSUE TO RIVAL GLOBAL WARMING, LOSS OF BIODIVERSITY, RESOURCE DEPLETION, ETC.  Barry Wood	391
54	DEVELOPMENT OF PAMAM DENDRIMER COMPOSITE ANTI- BIOFOULING NANOFIBER MATS FOR WATER FILTRATION  Ekonkar Singh Johal	399

No.	TITLES AND AUTHEORS	Page No.
55	EVALUATION OF THERMAL PROCESSES FOR REDUCTION OF SALMONELLA SPP. AND ESCHERICHIA COLI IN PORK SAUSAGES WRAPPED IN BANANA LEAVES Naruemon Prapasuwannakul, Mantana Panbualuang	406
56	ENSEMBLE DEA AND ITS COMPARISON WITH VARIABLE REDUCTION MODELS BASED ON ENTROPY MAXIMIZATION CRITERION Parag Pendharkar	412
57	IMPACTS OF FOREIGN RELIGION ON AFRICAN TRADITIONAL WORSHIP: THE IGBO EXAMPLE Egesi Jonathan	422
58	PLANT-FRUGIVORE MUTUALISM: SEED'S GREAT ESCAPE Inderdeep Kaur	430
59	DEVELOPMENT OF GLUTEN-FREE BISCUITS WITH RICEBERRY FLOUR Supatchalee Sirichokworrakit, Thanchanok Aungsirirak, Siwaporn Butmee	441
60	MAPPING THE COLONIAL CONQUER OF NATIVE MINDS: A SOCIO-HISTORIC CRITIQUE OF TURQUOISE BY AMIR HUSAIN Fauzia Janjua	449
61	TRAINING: A PANACEA OF CUSTOMER SERVICE INEFFICIENCY AND IMPOVING HOTEL PERFORMANCE AT OSOGBO, OSUN STATE, NIGERIA O.F. Mike-Rowland ,C.E. Ogunlade	458
62	CAN A MANAGEMENT AND INFORMATION SYSTEM BE AN ALTERNATIVE APPROACH TO UPSURGE EFFICIENCY FOR LOCAL ECONOMIC DEVELOPMENT PRACTICE IN KWAZULU-NATAL? Xoliswa Majola	466
63	MOTIVATIONAL FACTORS WHY STUDENTS ENROL AT DMMMSU CGS? Art Accredito Neroza , Remedios Neroza	473

No.	TITLES AND AUTHEORS	Page No.
64	THE ROLE OF LAW AND THE CHANGING FACE OF TERRORISM: A CASE STUDY OF BOKO HARAM IN NIGERIA  Tarela Juliet Ike, Kofi Kufuor, John Morrison, Anthony Richards	481
65	GENDER ROLES REPRODUCED: ONLINE SHOWCASES OF NEW BRIDES' HOMES  Zeynep Isil Isik Dursun	490
66	POPULATION DENSITY OF INSECT PEST ON CORN BIOMASS YIELD INTERCROP WITH LEGUMES  Ferdinand S. Corpuz , Myleen Corpuz	497
67	ECOLOGICAL AWARENESS IN ALAMGIR HASHMI'S POEMS  Mubina Talaat	506
68	COMPONENTS OF ETHICAL LEADERSHIP AND THEIR IMPORTANCE IN SUSTAINING ORGANIZATIONS OVER THE LONG TERM  Niall Hegarty, Salvatore Moccia	513
69	DESIRE OF SHOWING VS. FEAR OF SURVEILLANCE: A QUANTITATIVE RESEARCH OVER SURVEILLANCE ATTITUDES OF FACEBOOK USERS AND NON-USERS IN TURKEY  Demet Firat, Feyyaz Firat	521
70	FACTORS INFLUENCING ENTREPRENERSHIP START-UPS AMONG GRADUATE STUDENTS IN GHANA  Felicity Asiedu-Appiah, Bylon Abeeku Bamfo , Courage Simon Kofi Dogbe	530
71	MAGNITUDE OF DYNAMIC PRESSURE OF SUBSONIC AIRFLOW AROUND SYMMETRIC OBJECTS  Vsevolod Koryanov ,Erwin Martinez ,Shehret Tilvaldyev	539
72	THE RISE OF ISLAMIC FEMINISM: A COMPARATIVE ANALYSIS BETWEEN THE REPUBLIC OF IRAN AND SAUDI ARABIA  Dalia Elsayed	546

No.	TITLES AND AUTHEORS	Page No.
73	OF 'LOVE LAWS' AND THE DYNAMICS OF POWER PLAY: GENDER AS A SUBTEXT IN ARUNDHATI ROY'S THE GOD OF SMALL THINGS Pushpinder Walia	556
74	INCREASING STUDENT MOTIVATION AND LEARNER AUTONOMY THROUGH EXTENSIVE LISTENING PORTFOLIOS Jaime Morrish	568
75	THE NEW SACRED ART MOVEMENT AND DEVELOPMENT OF NIGERIAN ART: THE OSUN OSOGBO EXPERIMENT Egunjobi Felix Babatunde	576
76	CHILD TRAFFICKING AND ITS HUMAN IMPLICATION IN ETHIOPIA: THE CASE SNNPR STATE Alemshet Adugna Addisalem	586
77	CHILD TRAFFICKING AND ITS HUMAN IMPLICATION IN ETHIOPIA: THE CASE SNNPR STATE Alemshet Adugna Addisalem	594
78	INFLUENCE OF EXERCISE ON PERSONAL HEALTH PROFILE ON THE PEOPLE OF KABBA-BUNU LGA OF KOGI STATE NIGERIA Toluse Caroline Modupe	603
79	CONSUMERS' WILLINGNESS TO CONTRIBUTE TO THE IMPLEMENTATION OF A WORKPLACE SAFETY LABEL Marjia Khanom ,Mashiur Rahman	612
80	MEDICATION SAFETY STRATEGIES: A REVIEW AND SUGGESTIONS Hoppin Shari	621
81	THE ATTITUDES OF THE COLLEGE STUDENTS TOWARD THE UTILIZATION OF BRITISH RESTORATIVE JUSTICE TECHNIQUES IN EVERYDAY POLICING Jennifer Dawe, Margaret Duda, Rebekah Gonzales, Aqeel Saeid	630

No.	TITLES AND AUTHEORS	Page No.
82	REFUGEE INFLUX AND LIVELIHOOD OF THE HOST COMMUNITIES: A CASE STUDY OF NAKIVAALE REFUGEE SETTLEMENT, UGANDA Brendah Nakuya	639
83	TOURISM DEVELOPMENT IN EU REGIONS: AN ANALYSIS OF MONITORING STRATEGIES FOR FAST GROWING VISITORS COUNTRIES Renee Yi-Mond Yuan	648
84	STUDENTS' PERFORMANCE CHALLENGES AT INTERNSHIP IN KANO STATE, NIGERIA Attamah Chukwunwike Emmanuel	656
85	THE RAMAKIEN AND THE BIBLICAL ACCOUNT OF THE COSMIC CONTROVERSY Bienvisa Ladion Nebres	665
86	EFFECT OF GROUP COUNSELLING ON YOUTHS' ATTITUDE TOWARDS EXAMINATION MALPRACTICES IN LAGOS STATE, NIGERIA Ayodeji Olawole, Mopelola Olusakin	679
87	DETERRITORIALIZATION' IN THE WASTED VIGIL BY NADEEM ASLAM Sobia Kiran	690
88	EFL TEACHING IN UNIVERSITY CLASSROOMS IN SAUDI ARABIA: A CASE STUDY OF INSTRUCTORS AND CURRICULUM AND IMPLEMENTATION FOR LANGUAGE LEARNING Dalia Jamal Alghamdi	699
89	DAUGHTERS' NARRATIVES : THE DIALECTICS OF SILENCE AND MEMORY D. Laura Dameris Chellajothi	708
90	DEVELOPMENT AND ACCEPTABILITY OF THE FRUIT KAMIAS (AVERRHOA BILIMBI) Lilia M. Pingol , Gloria T. Tariga	716

No.	TITLES AND AUTHEORS	Page No.
91	RELIGIOUS VIOLENCE AND HERDSMEN AND TERRORIST PHENOMENA IN NIGERIA: A RHETORIC OR A REALITY Mary Taiye Daniel	725
92	ADVANCING ACADEMIC LEADER IDENTITY DEVELOPMENT: USING KAUPAPA TO BRIDGE THE DIVISION BETWEEN CONFLICTING ORGANISATIONAL CULTURES Steven Marshall	734
93	MANIFEST DESTINY AND NATIVE AMERICANS Serdar Ornek	743
94	A LESSINGIAN SOLUTION TO APOCALYPTIC DOOM IN WINTERSON'S THE STONE GODS: A SUFI APPROACH Neşe Yildirim	752
95	SYKES-PICOT AND THE FAILURE OF THE MODERN ARAB STATE SYSTEM Jawaher Abdel-Hamid	761
96	THE FUNCTION OF MUSIC IN FILM: THE RELATIONSHIP BETWEEN THE IMAGE AND THE MUSIC Rengin Iskeçe	771
97	THIS TIME SING FOR FREEDOM: THE ROLE OF PROTEST SONGS IN LIBERATION MOVEMENT OF SOUTH AFRICANS Seher Gündüz	779
98	EFFECTS OF SELECTED YOGIC ASNAS AND PRANAYAMAS ON LIPOPROTEIN CHOLESTEROL ABNORMALITIES AND DIABETIC POST MENOPAUSAL WOMEN Avtar Singh Kalsi ,Prabhjot Kaur, Satpal Kaur	785
99	PALIMPSEST AND REWRITING THE CANADIAN FEMINISM IN THE HAND MAID'S TALE Onur Kaya	792

No.	TITLES AND AUTHEORS	Page No.
100	ELECTROCHEMISTRY OF PYRROLOQUINOLINE QUINONE (PQQ) ON MULTI-WALLED CARBON NANOTUBE-MODIFIED GLASSY CARBON ELECTRODES IN BIOLOGICAL BUFFERS D. A. Baum , I. Emahi , M. P. Mitchell	800
101	DEVELOPMENT OF IOT-BASED CAR PARKING MANAGEMENT SYSTEM: THE DEPLOYMENT OF MOBILE TECHNOLOGY AND INTERNET OF THINGS FRAMEWORK Shutchapol Chopvitayakun	807



## Effect of Corn Cob Fiber Addition on Noodle Properties

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### ABSTRACT

Corn cob is a by-product of processed sweet corn used as animal feed in the farming industry. It returns to the farms as land applications such as fertilizer or it is disposed as the waste. The objective of this study was to determine the effect of addition of wheat flour with fiber from corn cob (5, 10, 15 and 20% w/w) on physical, chemical and sensory characteristics over the noodle quality. The corn cob fiber was extracted with 10% (w/v) NaOH at 25°C for 6 hours. According to this study, corn cob fiber had high level of crude fiber (52.34 g/100g). Noodle added with 20% corn cob fiber had the highest crude fiber and moisture content. Color of noodle added with corn cob fiber had lower lightness ( $L^*$ ) but higher redness ( $a^*$ ) and yellowness ( $b^*$ ) than the control sample (without corn cob fiber). The noodle with corn cob fiber had higher hardness and lower elasticity (tensile strength and breaking length) than the noodle without corn cob fiber. Cooking quality was changed when adding corn cob fiber, the cooking loss and water absorption increased. The noodle added with corn cob fiber at 10% gave the overall sensory score with acceptability that is not different from the control sample.

**Keywords:** Corn cob, Fiber, Addition, Noodle, Noodle properties.

## I. INTRODUCTION

Corn cob is a sweet corn processing industry by-product in Thailand. Nowadays, most of corn cobs are waste natural resources and also sources of environmental pollution (Wachirapakorn et al., 2016). The ratio between corn grain and corn cob may reach 100:18, a large quantity of corn cob can be generated (Cao et al., 2004). Cellulose and hemicellulose are the main dietary fibers in corn residues such as corn husk and cob (Yoon, Woodams, & Hang, 2006).

Dietary fiber is the edible plant portions which are undigestible and absorbable in human digestive system including polysaccharides, oligosaccharides, lignin, cellulose, hemicellulose, pectin, and gum (Stear, 1990; Mudgil, Barak, & Khatkar, 2016). Health benefits of consumption of dietary fiber are laxation, blood cholesterol attenuation, blood glucose

attenuation, reducing risk of coronary heart disease, diabetes, obesity, and some forms of cancer (AACC,2001; Mann & Cummings, 2009).

Noodles are staple foods that widely popular in Asian countries for more than 4,000 years, (Fu, 2008). Almost 40% of total wheat in Asia is used for noodle production (Janto et al., 1998). Many studies have been conducted to investigate the effect of fiber on noodle quality and evaluate the texture and sensory properties (Mudgil, Barak, & Khatkar, 2016; Rathod, & Annapure, 2017).

Therefore, the development of enriched noodle with corn cob fiber as the high dietary fiber content helps to increase the fiber intake. The purpose of this study was to investigate the effect of addition corn cob fiber towards chemical, physical, and sensory properties of noodle.

## **II. MATERIALS AND METHODS**

### **Preparation of Corn Cob Fiber**

Sweet corn was purchased from several local markets in Bangkok, Thailand. Corn husk, silks and kernels were removed from the cob. Corn cob was washed, boiled in hot water for 30 minutes, ground with blender and dried in a hot air oven at 60°C for 6 hours. Dried corn cob was extracted by using 2.5 M NaOH at 25°C for 6 hours and washed with water until it had pH at 7. The sample was dried at 60°C for 6 hours. Finally, ground into powder and sieved through a 60-mesh screen. The dried corn cob fiber was kept and sealed in a plastic bag at the room temperature for the further investigation.

### **Noodle Preparation**

Noodle formulation for this study is presented in table 1. Noodles were made from different amounts (0%, 5%, 10%, 15% and 20%) of corn cob fiber. The ingredients were mixed by a Kitchen Aid food processor (Kitchen Aid, USA), followed by hand kneading. The dough was sheeted and cut into noodle strands with 2 mm in width × 1 mm in thickness by noodle-making machine.

**Table 1.** Noodle formulation with different level of corn corbfiber

Ingredients	Corn corb fiber level (%)				
	Control (0)	5	10	15	20
Wheat flour	100	95	90	85	80
Corn corbfiber	0	5	10	15	20
Water	40	40	40	40	40
Salt	2	2	2	2	2
Sodium carbonate	2	2	2	2	2

**Analysis of Corn Cob Fiber and Noodle**

Moisture, fat, ash, crude fiber, protein, and carbohydrate contents of corn corb fiber and noodle were determined according to the AOAC methods (2005).

Colors of uncooked and cooked noodles were measured by using a spectrophotometer (Hunter Lab, Color Quest XE, USA) equipped with a light source illuminant D65 and 10° for observing. CIELAB system; L\* represents lightness (0-100), while a\* and b\* indicate the redness-greenness and yellowness-blueness, respectively.

Texture properties of noodle dough were measured using texture profile analysis (TPA) with texture analyzer (Lloyd Instrument, TA plus, UK). Noodle dough was compressed to 50% of original height at test speed of 50 millimeters per minute, using cylinder probe (3.5 centimeter diameter) with a 1 kN load cell. The parameters were obtained hardness (N), cohesiveness, springiness index, chewiness (kgf) and adhesiveness (Kgf). Noodle strands (uncooked and cooked) were determined tensile strength (maximum force; N) and breaking length (distance at maximum force; mm) according to the method of Sirichokwarakit et al. (2015).

The cooking properties of noodle were determined by following AACC method (2000). Noodle (10g) was cooked in 200 ml of boiling distilled water. Cooked noodle was rinsed with cold water and drained for 1 minute, and immediately weighed. Cooking water was evaporated and dried at 105°C to constant its weight. The percentage of cooking loss and water absorption were calculated using the following equations.

$$\text{Cooking loss (\%)} = (W_{dw} / W_{uc}) \times 100$$

Where  $W_{dw}$  is the weight of dried residue in cooking water (g);  $W_{uc}$  is the weight of uncooked noodle (g).

$$\text{Water absorption (\%)} = ((W_{co} - W_{uc}) / W_{uc}) \times 100$$

Where  $W_{co}$  is the Weight of cooked noodle (g);  $W_{uc}$  is the weight of uncooked noodle (g).

Sensory evaluation of noodle was evaluated by a 30 panels, they are faculty members, students and staff members of Suan Sunandha Rajabhat University. Six sensory attributes were

evaluated (color, odor, stickiness, softness, taste, and overall acceptability) using a 9-point Hedonic scale (1=dislike extremely and 9=like extremely).

**Statistical Analysis**

All tests and analytical measurements were done in triplicate. All data was processed by using the analysis of variance (ANOVA). The level of statistical significance is  $p \leq 0.05$ .

**III. RESULTS AND DISCUSSION**

**Chemical and Physical Properties of Corn Cob Fiber**

Proximate composition and color of raw corn cob and extracted corn cob fiber are shown in Table 2. The results show that crude fiber of extracted corn cob fiber increased from 29.27(g/100g) to 52.34(g/100g) increased to 78.82%. Hemicellulose is an insoluble dietary fiber over 40% dry matter in corn cob (Barl, Biliaderis, Murray, & MacGregor, 1991). However, protein and carbohydrate content in extracted corn cob fiber had lower than raw corn cob. Extracted corn cob fiber had more lightness ( $L^*$ ) than raw corn cob but redness and yellowness are lower than raw corn cob due to extraction with NaOH removed  $\beta$ -catotene from raw corn cob.

**Table 2.** Chemical composition and color parameters of raw corn cob and extracted corn cob fiber

	raw corn cob	extracted corn cob fiber
Chemical Composition (g/100g)		
Moisture <sup>ns</sup>	5.31	5.99
Fat <sup>ns</sup>	0.20	0.18
Ash <sup>ns</sup>	0.76	0.68
Crude fiber	29.27 <sup>b</sup>	52.34 <sup>a</sup>
Protein	3.59 <sup>a</sup>	0.68 <sup>b</sup>
Carbohydrate	60.87 <sup>a</sup>	40.13 <sup>b</sup>
Color parameter		
$L^*$	68.95 <sup>b</sup>	75.27 <sup>a</sup>
$a^*$	4.14 <sup>a</sup>	1.51 <sup>b</sup>
$b^*$	25.03 <sup>a</sup>	18.64 <sup>b</sup>

Mean in the same row with different letters are significantly different ( $p \leq 0.05$ )

<sup>ns</sup> = no significant difference ( $p > 0.05$ )

**Chemical Composition of Noodle**

Proximate composition of noodles added with different levels of corn cob fiber (0, 5 10, 15 and 20%) is presented in Tabel 3. The results indicated that noodle with 20% corn cob fiber had the highest moisture and crude fiber content. On the other hand, addition of corn cob fiber, it also decreases the content of ash, protein, and carbohydrate.

### Color of Uncooked and Cooked Noodle

The values of color (lightness, redness, and yellowness) of uncooked and cooked noodle are shown in Table 4. The results showed that noodle (uncooked and cooked) added with 20% corn cob fiber had the lowest lightness ( $L^*$ ). Addition of corn cob fiber affected the increasing of redness ( $a^*$ ) and yellowness ( $b^*$ ) when compared with control sample because of  $\beta$ -carotene in corn cob.

**Table 3.** Chemical composition of noodle

Chemical composition (g/100g)	Corn cob fiber level (%)				
	Control (0)	5	10	15	20
Moisture	35.41 <sup>e</sup>	38.66 <sup>d</sup>	39.50 <sup>c</sup>	41.11 <sup>b</sup>	43.39 <sup>a</sup>
Fat	0.09 <sup>b</sup>	0.29 <sup>a</sup>	0.30 <sup>a</sup>	0.43 <sup>a</sup>	0.45 <sup>a</sup>
Ash	3.06 <sup>a</sup>	2.71 <sup>ab</sup>	2.65 <sup>ab</sup>	2.44 <sup>b</sup>	2.36 <sup>b</sup>
Crude fiber	0.30 <sup>e</sup>	1.69 <sup>d</sup>	3.06 <sup>c</sup>	4.71 <sup>b</sup>	5.96 <sup>a</sup>
Protein	10.61 <sup>a</sup>	8.41 <sup>b</sup>	8.13 <sup>b</sup>	7.09 <sup>c</sup>	6.11 <sup>d</sup>
Carbohydrate	50.50 <sup>a</sup>	48.20 <sup>b</sup>	46.33 <sup>c</sup>	44.24 <sup>d</sup>	41.63 <sup>e</sup>

Mean in the same row with different letters are significantly different ( $p \leq 0.05$ )

**Table 4.** Color of uncooked and cooked noodle

Color parameters	Corn cob fiber level (%)				
	Control (0)	5	10	15	20
Uncooked					
$L^*$	75.56 <sup>a</sup>	74.43 <sup>a</sup>	74.14 <sup>a</sup>	73.05 <sup>a</sup>	69.26 <sup>b</sup>
$a^*$	-0.19 <sup>c</sup>	0.51 <sup>b</sup>	0.84 <sup>b</sup>	0.97 <sup>b</sup>	1.85 <sup>a</sup>
$b^*$	21.65 <sup>b</sup>	24.33 <sup>a</sup>	24.01 <sup>a</sup>	23.93 <sup>a</sup>	23.26 <sup>a</sup>
Cooked					
$L^*$	65.89 <sup>a</sup>	65.54 <sup>a</sup>	62.84 <sup>b</sup>	61.73 <sup>bc</sup>	60.25 <sup>c</sup>
$a^*$	0.32 <sup>e</sup>	1.45 <sup>d</sup>	2.09 <sup>c</sup>	2.64 <sup>b</sup>	3.11 <sup>a</sup>
$b^*$	26.49 <sup>c</sup>	27.47 <sup>b</sup>	27.45 <sup>b</sup>	27.63 <sup>b</sup>	28.46 <sup>a</sup>

Mean in the same row with different letters are significantly different ( $p \leq 0.05$ )

### Texture Properties of Uncooked and Cooked Noodle

Table 5. shows texture profile analysis of noodle dough added with corn cob fiber. Noodle with 20% corn cob fiber had the highest hardness and chewiness. However, cohesiveness, springiness index, and adhesiveness of all noodle samples were not significantly different ( $p > 0.05$ ).

**Table 5.** Texture profile analysis of noodle dough

Texture parameters	Corn corb fiber level (%)				
	Control (0)	5	10	15	20
Hardness (N)	4.38 <sup>c</sup>	5.15 <sup>c</sup>	7.87 <sup>b</sup>	8.62 <sup>b</sup>	9.53 <sup>a</sup>
Cohesiveness <sup>ns</sup>	0.10	0.10	0.10	0.14	0.15
Springiness index <sup>ns</sup>	0.16	0.18	0.18	0.24	0.24
Chewiness (Kgf)	0.13 <sup>c</sup>	0.17 <sup>c</sup>	0.29 <sup>b</sup>	0.48 <sup>a</sup>	0.59 <sup>a</sup>
Adhesiveness (Kgf) <sup>ns</sup>	0.46	0.50	0.65	0.47	0.34

Mean in the same row with different letters are significantly different ( $p \leq 0.05$ )

<sup>ns</sup> = no significant difference ( $p > 0.05$ )

Table 6. shows texture characteristics of uncooked and cooked noodle strands. Tensile strength of uncooked noodle strand with corn cob fiber had lower tensile strength and breaking length than the noodle without corn cob fiber. On the contrary, tensile strength of cooked noodle samples were not significantly different ( $p > 0.05$ ). Moreover, cooked noodle sample added with 5% corn cob fiber was not significantly different when compare to control sample. Tensile strength and elasticity are important attributes of noodle because they can influence the consumer preferences (Li et al., 2014). The results indicate that gluten network could be disterupted by the presence of fiber particles.

**Table 6.** Texture analysis of noodle strands

Texture parameters	Corn corb fiber level (%)				
	Control (0)	5	10	15	20
Uncooked					
Tensile strength (N)	0.09 <sup>a</sup>	0.05 <sup>b</sup>	0.04 <sup>b</sup>	0.03 <sup>b</sup>	0.02 <sup>b</sup>
Breaking length (mm)	88.80 <sup>a</sup>	54.50 <sup>b</sup>	26.80 <sup>c</sup>	17.70 <sup>d</sup>	15.87 <sup>d</sup>
Cooked					
Tensile strength (N) <sup>ns</sup>	0.05	0.05	0.04	0.04	0.03
Breaking length (mm)	30.20 <sup>a</sup>	24.70 <sup>a</sup>	13.90 <sup>b</sup>	12.80 <sup>bc</sup>	9.35 <sup>c</sup>

Mean in the same row with different letters are significantly different ( $p \leq 0.05$ )

<sup>ns</sup> = no significant difference ( $p > 0.05$ )

### Cooking Properties of Noodle

Cooking loss and water absorption are shown in Table 7. Cooking loss is an indicator to cooking resistance of noodle, low cooking loss is preferable. The results show that the increasing of corn cob fiber was responsible for increased cooking loss and water absorption, due to water is allow to penetrate readily into the noodle strand.

**Table 7.** Cooking properties of noodle

Cooking parameters	Corn corb fiber level (%)				
	Control (0)	5	10	15	20
Cooking loss (%)	6.72 <sup>e</sup>	10.86 <sup>d</sup>	15.39 <sup>c</sup>	18.16 <sup>b</sup>	21.66 <sup>a</sup>
Water absorption (%)	74.46 <sup>d</sup>	77.89 <sup>d</sup>	99.13 <sup>c</sup>	145.06 <sup>b</sup>	179.58 <sup>a</sup>

Mean in the same row with different letters are significantly different ( $p \leq 0.05$ )

### Sensory Evaluation

Table 8. presents the sensory attributes of cooked noodles that were compared for color, odor, stickiness, softness, taste, and overall acceptability. Addition of corn cob fiber at various levels had no significantly different in odor score. Furthermore, noodles with added corn cob fiber at the levels 5, and 10 were not significantly different compare to control sample for stickiness, softness, taste, and overall acceptability. Accordingly, in this study noodle added with 10% corn cob fiber is suggested to produce for improve high fiber noodle.

**Table 8.** Sensory evaluation of noodle

Texture parameters	Corn corb fiber level (%)				
	Control (0)	5	10	15	20
Color	7.79 <sup>a</sup>	7.63 <sup>b</sup>	7.59 <sup>b</sup>	7.43 <sup>b</sup>	6.58 <sup>c</sup>
Odor <sup>ns</sup>	7.66	7.62	7.08	7.37	7.25
Stickiness	7.35 <sup>a</sup>	7.22 <sup>a</sup>	7.11 <sup>a</sup>	6.89 <sup>b</sup>	6.37 <sup>b</sup>
Softness	7.53 <sup>a</sup>	7.33 <sup>a</sup>	7.29 <sup>a</sup>	6.62 <sup>b</sup>	6.37 <sup>b</sup>
Taste	7.37 <sup>a</sup>	7.25 <sup>a</sup>	7.20 <sup>a</sup>	6.54 <sup>b</sup>	6.20 <sup>c</sup>
Overall acceptability	7.70 <sup>a</sup>	7.59 <sup>a</sup>	7.25 <sup>a</sup>	6.91 <sup>b</sup>	6.20 <sup>c</sup>

Mean in the same row with different letters are significantly different ( $p \leq 0.05$ )

<sup>ns</sup> = no significant difference ( $p > 0.05$ )

## IV. CONCLUSION

Addition of corn cob fiber affected chemical, physical and sensory properties of noodles. Corn cob fiber as a fortification in noodle formulation resulted the higher crude fiber content that improve nutrition value and health benefits. Increasing of corn cob fiber decreased lightness ( $L^*$ ) but increased redness ( $a^*$ ) and yellowness ( $b^*$ ). Noodle dough added with corn cob fiber had the higher hardness and chewiness when compared with control sample. Moreover, tensile strength and breaking length of uncooked noodle strand with corn cob fiber had lower than control. Cooking loss and water absorption increased when added with corn cob fiber. Noodles that were added corn cob fiber at 10 were not significantly different in stickiness, softness, taste, and overall acceptability scores from control sample.

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