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A Corpus-Driven Investigation into Lexical Bundles across Research Articles in Food Science andTechnology

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Abstract

The purpose of this study was twofold: (a) to identify the most frequent 4-word lexical bundles and (b) to analyse the functions these lexical bundles may serve. To those ends, a corpus of 4,652,444 in Food Science and Technology (hereafter FST Corpus) was developed, using 1,421 research articles (RAs) across 38 Food Science and Technology (FST) journals. Setting frequency and range as two criteria, we used AntConc to identify the most frequent lexical bundles. We also used Hyland's (2008b) functional taxonomy to analyse the functions of the lexical bundles. The results of frequency and range showed 153 lexical bundles in FST Corpus. Functional analysis of the lexical bundles revealed 86 text-oriented, 63 research-oriented, and four participant-oriented lexical bundles, suggesting the central role text-oriented functions may play in FST. Implications for the explicit instruction of lexical bundles, for graduate students in FST, and for EAP curriculum developers and materials producers are discussed.

Key words: Lexical bundles, corpus, Food Science and Technology, range

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1. Introduction

The most frequent lexical bundles contribute considerably to language learners' language proficiency and vocabulary knowledge. Biber, Johansson, Leech, Conrad, and Finegan (1999) first coined the term "lexical bundles" and defined them as "recurrent expressions, regardless of their idiomaticity, and regardless of their structural status" (p. 990). Biber and Barbieri (2007) defined them simply as "the most frequently recurring sequences of words" (p.264).

The study of lexical bundles, according to Hyland (2012), as well as Conrad and Biber (2004), was pioneered by Altenberg (1998), who introduced the methodology of identifying the frequently recurring word combinations. Following Altenberg, researchers, including McCarthy and Carter (2006), Hyland (2008a, 2008b), Chen and Baker (2010), Byrd and Coxhead (2010), Adel and Erman (2012), Karabacak and Qin (2012), and Alquraishi (2014) have worked on lexical bundles and contributed to the literature in this area. These studies basically focus on identifying lexical bundles in a certain discipline, looking for their similarities and differences which occur across different fields of study, registers, and genres.

Another area in lexical bundles has to do with how lexical bundles function in different text types. Three main functions have been identified: research-oriented, text-oriented, and participant-oriented (Hyland, 2008b), each with their own subcategories. Researchers, including Biber and Barbieri (2007), Biber, Conrad, and Cortes (2004), Biber, Conrad, and Cortes (2003), Cortes, (2001, 2002, 2004); and Hyland, (2008a, 2008b) also regard the contribution to the organization and coherence of different texts that lexical bundles make.

Hyland (2012) claimed that lexical bundles are important to writers and speakers for three reasons: "(1) their repetition offers users (and particularly students) ready-made sets of words to work with, (2) they help define fluent use and therefore expertise and legitimate disciplinary membership, (3) they reveal the lexico-grammatical community-authorized ways of making-meanings" (p.153).

These advantages of lexical bundles have motivated researchers across the globe to analyse lexical bundles across different disciplines, registers, and genres; however, no study has been carried out to examine the most frequent lexical bundles and the functions these bundle may serve in FST. The present study sought to use a corpus of RAs in FST to analyse the frequency and functions of lexical bundles in this discipline.

2. Literature Review

2.1 Lexical Bundles

Three defining characteristics of lexical bundles that distinguish them from other multi-word expressions include frequency of occurrence, fixedness, and incompleteness. Lexical bundles, as Biber (2010) put it, are frequently recurring multi-word sequences that are distributed across various text types. Frequency of occurrence is, therefore, the most important feature of lexical bundles.

While investigating lexical bundles, researchers assign arbitrary frequency thresholds, or cut-off points, which vary from one study to another, depending on corpus size, mode of presentation, discipline, genres, and registers. In studies of spoken data, higher cut-off points such as 40 times of occurrence per million are typical (Biber et al., 2004; Biber et al., 1999). In written corpora, lower cut-off points can be used (Chen & Baker, 2010; Cortes, 2004).

Another characteristic of bundles is fixedness. Lexical bundles consist of fixed sequences of words and, in fact, have one permanent grammatical structure. For example, the lexical bundle *as a result of* cannot be found in plural form. Finally, they are not complete structures and "they are not units that linguists would recognize using their intuition" (Conrad & Biber, 2004, p. 58). For instance, *in the absence of, a flow rate of,* and *the result of the* are some frequent lexical bundles, but none are recognized as structurally complete (Biber & Barbieri, 2007; Conrad & Biber, 2004; Kashiha & Heng, 2014).

Lexical bundles are divided into two major categories: structural and functional. Functional category refers to the meaning the lexical bundles may have. Hyland (2008b) identified three main functional categories:

- Research-oriented bundles help writers to structure their activities and experiences of the real world.
- Text-oriented bundles are concerned with the organisation of the text and its meaning as a message, or an argument.
- Participant-oriented bundles focus on the writer, or reader of the text.

Structural category, on the other hand, refers to the grammatical forms lexical bundles may assume. Biber et al.'s (1999) most common four word lexical bundles in academic writing are presented in Table 1. Table 2 shows three main structural types of lexical bundles.

Table 1

The Most Common Four Word Bundles Patterns in Academic Writing (Biber et al., 1999, p. 997).

Structure	Examples
Noun phrase + of	the end of the, the nature of the, the beginning of the, a large number of
Other noun phrases	the fact that the, one of the most, the extent to which
Prepositional phrase + of	at the end of, as a result of, on the basis of, in the context of
Other prepositional phrases	on the other hand, at the same time, in the present study, with respect to the
Passive + prep phrase fragment	is shown in figure, is based on the, is defined as the, can be found in
Anticipatory it + verb/adj	it is important to, it is possible that, it was found that, it should be noted
Be + noun/adjectival phrase	is the same as, is a matter of, is due to the, be the result of
Others	as shown in figure, should be noted that, is likely to be, as well as the

Length is an essential factor to identify lexical bundles. For instance, Biber et al. (1999) investigated three- to six-word long lexical bundles, and McCarthy and Carter (2006) analyzed the sequences of two- to six-word long lexical bundles and noted that there is no practicality in looking for longer than six-word lexical bundles. However, researchers such as Biber et al. (2004), Cortes (2004), Biber and Barbieri (2007), and Adel and Erman (2012) focused their study on only four word bundles as they believed that they are more common.

Another criterion is range or dispersion which sometimes is reported in the literature to identify lexical bundles. Range means a lexical bundle must occur in various text types in a certain register in order for it to be selected (Biber et. al., 1999). For instance, lexical bundles must occur in at least 10 texts of the whole corpus of the study in order to be included in the list (Biber & Barbieri, 2007). This criterion is to avoid any possible idiosyncrasies.

2.2 A Selective Review of Empirical Studies on Lexica Bundles

Conrad and Biber (2004) identified the most frequent four-word lexical bundles, using a fixed cut-off point. They analysed the structural and

Table 2
Structural Types of Lexical Bundles (Biber et al., 2004, p.381).

Structural types	Sub-types	Sample bundles
1. Lexical bundles that incorporate verb phrase fragments	1a.1 st/2nd person pronoun+ VP fragments	*I am not going to*
	1b. 3rd person pronoun+ VP fragment s	*And this is a*
	1c. Discourse markers+VP fragments	*I mean I don't*
	1d. Verb phrase(with non - passive verbs)	*Have a lot of*
	1e. Verb phrase(with passive verbs)	*Is based on the*
	1f. Yes. No question fragments	*Are you going to*
	1g. WH-question fragments	*What do you think*
2. Lexical bundles that incorporate dependent-clause fragments	2a. 1st/ 2nd person pronoun+dependne clause fragment	*I want you to*
	2b. WH-clause fragments	*When we get to*
	2c. If- clause fragments	*If we look at*
	2d. To-clause fragments	*To be able to*
	2e. That-clause fragments	*That this is a*
3. Lexical bundles that incorporate noun phrase and prepositional phrase fragments	3a. Noun phrase with *of*-phrase fragments	*One of the things*
	3b. Noun phrase with other post-modifier fragments	*The way in which*
	3c. Other noun phrase expressions	*A little bit more*
	3d. Prepositional phrase expressions	*At the end of*
	3e. Comparative expressions	*As well as the*

functional features of the lexical bundles and concluded that lexical bundles could be useful building blocks of discourse, capable of conveying meanings and achieving communicative goals.

Following this study, Cortes (2006) basically focused her study on lexical bundles in English native speakers' disciplinary writing. Three stages were involved in this study. In the first stage, pre-instruction analysis occurred, in which a corpus of 800,000 running words were developed. Next was the instruction phase by teaching the list of 35 lexical

bundles from the previous stage. The final stage was the post-instruction analysis of the target bundles in students' pieces of writing. Cortes found no major improvement in diversity and frequency of the use of target bundles. Students greatly favored more structurally simpler expressions, including mostly connectors, discourse particles, and discourse markers.

Biber and Barbieri (2007) investigated the use of lexical bundles in a wide range of both written and spoken university registers. In addition, they studied the three major functions lexical bundles serve: stance expressions, discourse organizers, and referential expressions. Biber and Barbieri set the cut-off frequency at 40 times per million words and focused on only four-word lexical bundles. They identified three basic patterns: "the pervasiveness of lexical bundles in university language; the strong functional basis of lexical bundles; and the extent to which each register is associated with a distinctive set of bundles, serving particular discourse functions" (p.283). They also found that these high-frequency sequences are not just some accidental occurrences, but they serve very important and significant discourse functions in both written and spoken genres. Biber and Barbieri concluded that there is a fundamental difference in the patterns between lexical bundles and other lexico-grammatical features: "grammatical features are influenced primarily by physical mode (speech versus writing), while the use of lexical bundles is influenced by both mode and communicative purpose" (p. 282).

Hyland (2008b) used three written corpora with 3.5 million running words including PhD dissertations, research articles, and MA/MSs theses of four different disciplines: Biology, Electrical engineering, Applied Linguistics, and business studies. Hyland found that Electronic engineering included a wide range of 213 lexical bundles while Biology included only 131 lexical bundles. The results also showed that Biology and Electronic engineering greatly relied on research-oriented functions while Applied Linguistics and Business studies relied on text-oriented functions. This variation in frequency and function proves that research writers draw on various possible resources to express their thoughts and ideas.

Allen (2009) investigated the use of lexical bundles across science research articles which followed Introduction-Methods-Results-Discussion (IMRD) format, focusing broadly on written academic English register. Allen identified 144 lexical bundles and analyzed the functions of the most frequent lexical bundles. He found that the research-oriented bundles were the most frequent, and participant-oriented bundles were least frequent. Further analysis of the results revealed that certain lexical bundles are suitable for designing learning activities, using concordances.

Coxhead and Byrd (2010) examined Academic Word List (AWL) to find lexical bundles across a variety of disciplines the corpus was

comprised of. Arts and Sciences had the lowest number of lexical bundles while Law included the highest number of lexical bundles. Commerce fell in between. They obtained a shared list of 21 lexical bundles among these four academic disciplines. They suggested that teachers use these lists to help learners understand how they are used in different text types.

Adel and Erman (2012) looked into the lexical bundles in the pieces of writing advanced level nonnative speakers (L1 Swedish) and compared them to those of native (British) speakers. The results showed that non-native speakers in comparison with native speakers "exhibit a more restricted repertoire of recurrent word combinations" (Adel & Erman, 2012, p. 90). The results of the functional analysis of their corpus revealed that the proportions for referential expressions in both groups were almost the same. Stance bundles had greater proportions, but discourse organizers had smaller proportions among native speakers.

Karabacak and Qin (2013) conducted a study aimed at examining the use of lexical bundles in argumentative articles on current events written by Turkish, American, and Chinese university students. A list of target lexical bundles was drawn from New York Times and SF Gate newspapers with which the student pieces of writing were compared to investigate how often these target bundles occurred. The results showed the highest number of five-word lexical bundles in American writers' papers and the lowest in those of Chinese. The authors concluded that even non-native advanced learners cannot master lexical bundles through simple exposure and there needs to be explicit teaching through which the acquisition process is speeded up a bit more.

A year later, Beng and Keong (2014) conducted a study analyzing the use of lexical bundles in reading passages in the Malaysian University English Test (MUET). The objective of the study was three-fold: (i) to investigate commonly used bundles in MUET, (ii) to identify the structural categories of lexical bundles, and (iii) to compare and contrast structural types in Arts and Science texts. Beng and Keong identified 730 lexical bundles including two-, three-, and four-word lexical bundles. The results showed that the three most frequent structures occurring across the corpus were PP + NP, NP + post modifier, and V/Adj + to clause. The scientific-based texts employed more forms of NP-, and VP-based bundles because of the more argumentative nature of science articles while art-based texts included more independent clauses. In addition, results revealed that, to convey the intended meaning, authors seek the help of certain patterns of language mainly based on the context of the reading passages.

Finally, Grabowski (2015) presented a corpus-driven description of use and functions of lexical bundles across patient information leaflets

(PILs), summaries of product characteristics (SPCs), clinical trial protocols (CTPs) and selected chapters from academic textbooks on pharmacology (ATs). ATs had the highest and CTPs lowest number of lexical bundles followed by SPCs and PILs. Grabowski was able to establish a strong link between communicative purposes and situational use of these four divisions and the most frequent words used in these texts. To identify the functions of bundles, Grabowski conducted qualitative concordance-based analysis in which "a text-type specific functional classification" (p. 28) of the bundles was made by examining co-text and context of the 50 top four-word long lexical bundles. The comparisons showed differences among the four sub-corpora in the functions of most lexical bundles. PILs were dominated by stance bundles, SPCs by referential, CTPs by discourse organizing, and ATs by both referential and discourse organizing.

None of the studies reviewed above examined lexical bundles in FST. Therefore, in this study, we analysed the most frequent four-word lexical bundles across research articles in FST. We also examined the functions these lexical bundles served. Following these two goals, we formulated the following research questions to focus our study:

1. What are the most frequent four-word lexical bundles in FST?
2. What are the functions of the most frequent four-word lexical bundles in FST?

3. Method

3.1 Corpus Development

A corpus of 4.7 million running words from 1,421 RAs was developed. In order to create the FST Corpus, first, two content specialists were consulted to identify the sub-disciplines of FST. Four sub-disciplines—Food Chemistry, Food Engineering, Food Microbiology, and Food Technology—were identified. The list of these four subject areas was e-mailed to another two content specialists. They all agreed on the four sub-disciplines, but they suggested Food Quality Control be regarded as another sub-discipline, as these two content specialists commented, it has a long and distinguished history in FST. Therefore, five sub-disciplines were finalized. Next, with the help of the content specialists, journals related to each sub-discipline were identified. They suggested choosing journals with an Impact Factor (If) above 1.00 and those hosted by major international publishers, including Elsevier, Sage, and Springer.

Finally, a long list of 86 journals was established. The journals were categorized into the five sub-disciplines. Eight journals for each sub-discipline except for Food Quality Control were randomly selected. For Food Quality Control, only six journals with an IF were identified, so all

of them were included. The resultant list included 38 journals for the creation of the corpus in this study.

The RAs for the FST Corpus were downloaded from the Library Genesis online database. The RAs had to follow Introduction-Method-Results-Discussion (IMRD) format (Swales, 1990). Therefore, any RA that did not follow IMRD format was eliminated. The selected RAs had been published in the period spanning 2000 and 2014, and only those ranging in length between 1,800 and 7,000 words were chosen. As shown in Table 3, the number of RAs downloaded for each sub-discipline varied according to the length of the RAs and number of words.

Table ·

The Number of Journals, RAs, and Words in Each Sub-Discipline

Sub-disciplines	No. of Journals	No. of RAs	NO. of Words
Food Chemistry	8	294	979,958
Food Microbiology	8	294	978,444
Food Engineering	8	297	984,604
Food Technology	8	284	975,714
Food Quality Control	6	252	733,724
Total	38	1421	4,652,444

All the RAs were in PDF format which were first copied into Microsoft Word and later converted into text files (saved in the *.txt. file format) so that they could be readable by computer program used to analyze the data. Only Introduction, Materials and Method, Results, and Discussion sections were copied, but the Abstract, Conclusion, and Acknowledgment sections were left out.

Titles, figures, pictures, tables, charts, formulas, acknowledgments, reference lists, bio data, appendices, and authors' information were completely manually removed to eliminate any possible factors affecting the analysis of data and to ensure that the texts included in the corpus were readable by the computer program. In other words, what was copied was pure text. In the end, all the RAs in each of the journals were copied and pasted into one text files. This provided us with five sub-disciplines and eight text files including all the RAs.

3.2 Criteria to Identify Lexical Bundles

We used three criteria to identify lexical bundles: frequency, range, and length. Setting a frequency cut-off point is somewhat arbitrary. The cut-off point determines the number of lexical bundles to be included in the analysis. The normalized frequency for large written corpora ranges from 20 to 40 per million words (PMWs). For instance, Biber, Conrad, and Cortes (2004) set their cut-off point at 40 PMWs, but Hyland (2008b) set

it at at 20 PMWs, yet in small corpora the frequency cut-off is often set on a range from 2-10 (Chen & Baker, 2010). In our study, we set the cut-off point at 20 PMWs. For a word combination in this study to be regarded as a lexical bundle, it had to occur at least 94 times in the FST Corpus.

Range, or dispersion, is the second criterion to guarantee a word combination to be considered a lexical bundle. Range requires that a sequence occur between three and five times in each file. This criterion is to guard against any possible idiosyncratic or repetitive uses from individual writers. Therefore, in this study, lexical bundles had to occur at least five times in each text file, or at least in half of 38 journals.

The third, and the final, criterion concerns the length of word combinations. Lexical bundles of 2-, 3-, 4-, 5-, and 6-words have been reported in the literature (Hyland, 2008a, 2012). Shorter bundles—2-, and 3-word-long bundles—are often incorporated into longer combinations. Biber et al. (1999) suggested that longer than four-word lexical bundles are more phrasal in nature and thus less common. However, four-word bundles are far more common than five- or six-word ones in written corpora, according to Hyland (2012), who stated "they are over 10 times more frequent than five-word sequences and offer a wider variety of structures and functions to analyze" (p.151). In addition, McCarthy and Carter (2006) noted the impracticality of looking for lexical bundles longer than six words, even when using a very liberal. In fact, four-word combinations consist of smaller three-word combinations. Therefore, in this study only four-word lexical bundles were identified.

3.3 Instrumentation

To identify the most frequently recurring lexical bundles, AntConc concordancing program developed by Anthony (2014) was used. This freeware corpus analysis toolkit offers comprehensive textual analysis options such as word lists, collocates, n-grams, and clusters for researchers and students. AntConc was designed specifically for use in the classroom and runs on both Windows and Linux/Unix based systems (Anthony, 2005, 2014). The program scans the corpus word by word and stores the repeated instances of multiple-word sequences. Then, the concordancer identifies the bundles that occur in the corpora by a rate at or above the cut-off point.

3.4 Procedure

AntConc sorted the frequency and range of lexical bundles. Lexical bundles had to meet the criteria for frequency and range set at in Method section. Moreover, five exclusion criteria were applied to the list in order to satisfy the pedagogical objectives of this study. The fact that all the word sequences of the master list should meet the frequency and range

criteria does not necessarily mean that they all fall within the scope of the present study, or, more importantly, they equally benefit learners. Therefore, five additional criteria were established to further narrow down the list to more valuable lexical bundles. These exclusion criteria are: topic-specific bundles: *vitro and in vivo*; bundles with random numbers: *washed three times with*; temperature, volume, and length bundles: *rpm for min the*; random section bundles: *Fig a and b*; and meaningless bundles: *x s multiple range* (Salazar, 2008).

Table 4

Functional Taxonomy of the Target Bundles (Adopted from Hyland, 2008b, pp.13-14).

Research-oriented	**Text-oriented**	**Participant-oriented**
Helps writers to structure their activities and experiences of the real world	Concerned with the organization of the text and its meaning as a message or argument	Focused on the writer or reader of the text
Location	**Transition signals**	
Indicate time/place and extremity	Establishing additive or contrastive links between elements	
at the beginning of, at the same time, in the present study	on the other hand, in addition to the, in contrast to the	
Procedure	**Resultative signals**	**Engagement features**
Indicate events, actions, and methods	Mark inferential or causative relations between elements	Address readers directly
the use of the, the role of the, the purpose of the, the operation of the	as a result of, it was found that, these results suggest that	it should be noted that, as can be seen
Quantification	**Structuring**	
Indicate measures, quantities, proportions, and changes thereof	text-reflexive markers which organize stretches of discourse or direct reader elsewhere in text	
the magnitude of the, a wide range of, one of the most	in the present study, in the next section, as shown in figure	
Description	**Framing**	
Indicate quality, degree, and existence	Situate arguments by specifying limiting conditions	
the structure of the, the size of the, the surface of the	in the case of, with respect to the, on the basis of, in the presence of, with the exception of	
Topic		
Related to the field of research		
in the Hong Kong, the currency board system		

When the list of lexical bundles was finally established, they were analyzed for their functions. The three main functions investigated in this study were: research-oriented, text-oriented, and participant-oriented, each with their own subcategories (Hyland, 2008b). Table 4 lists the functional categories in this framework along with definitions and examples.

4. Results and Discussion

4.1 Investigation of the first research question

To answer the first research question, "What are the most frequent four-word lexical bundles in FST?", the FST Corpus was processed using AntConc. According to the descriptions provided in Method section, a list of 153 most frequently occurring 4-word lexical bundles in the FST Corpus was finalized after applying frequency and range.

Table 5

The 30 Most Frequently Occurring Lexical Bundles in the FST Corpus

Lexical bundles	Frequency	Range
on the other hand	859	38
in the present study	811	38
in the presence of	695	37
in the case of	605	38
as a function of	491	33
as shown in fig	479	34
at the end of	463	38
are shown in table	350	38
used in this study	348	37
as well as the	347	38
was found to be	339	38
as a result of	329	38
on the basis of	317	38
be due to the	302	37
in the range of	293	37
are shown in fig	282	34
is shown in fig	278	33
an increase in the	275	38
in this study the	270	38
the effect of the	251	38
was added to the	249	38
one of the most	241	38
the results of the	239	37
a flow rate of	236	36
according to the method	222	37
a wide range of	220	38
in the absence of	204	35
was used as a	204	38
this study was to	199	37
has been shown to	196	36

The most frequently occurring lexical bundle was *on the other hand* with a frequency of 859, and the least frequently occurring lexical bundle were *can be used as, in the production of,* and *results were expressed as* with a frequency of 100. The 30 most frequently occurring lexical bundles are shown in Table 5 (see appendix A for full list of lexical bundles).

4.2 Investigation of the Second Research Question

The second research question was aimed at exploring the functions of the most frequent four-word lexical bundles of the FST Corpus. As discussed in Method section, the functional characteristics of the bundles were studied through careful concordance analysis which made it possible to classify the lexical bundles using the framework by Hyland (2008b), who classified the functions of lexical bundles into three main categories:

Table 6

Functional Description of the Top 30 most Frequent Bundles

Sub-categories	Tokens	Functions
Transition	on the other hand	Text-Oriented
Structuring	in the present study	Text-Oriented
Framing	in the presence of	Text-Oriented
Framing	in the case of	Text-Oriented
Framing	as a function of	Text-Oriented
Structuring	as shown in fig	Text-Oriented
Location	at the end of	Research-Oriented
Structuring	are shown in table	Text-Oriented
Procedure	used in this study	Research-Oriented
Transition	as well as the	Text-Oriented
Resultative	was found to be	Text-Oriented
Resultative	as a result of	Text-Oriented
Framing	on the basis of	Text-Oriented
Resultative	be due to the	Text-Oriented
Quantification	in the range of	Research-Oriented
Structuring	are shown in fig	Text-Oriented
Structuring	is shown in fig	Text-Oriented
Quantification	an increase in the	Research-Oriented
Structuring	in this study the	Text-Oriented
Resultative	the effect of the	Text-Oriented
Procedure	was added to the	Research-Oriented
Quantification	one of the most	Research-Oriented
Resultative	the results of the	Text-Oriented
Quantification	a flow rate of	Research-Oriented
Procedure	according to the method	Research-Oriented
Quantification	a wide range of	Research-Oriented
Description	in the absence of	Research-Oriented
Procedure	was used as a	Research-Oriented
Structuring	this study was to	Text-Oriented

research-oriented, text-oriented, and participant-oriented, with each divided into sub-categories. Once the list of most frequent lexical bundles in the FST Corpus was finalized, the researchers determined the function each of the lexical bundles serves in the corpus (see Appendix B). This classification scheme made it possible first to organize the lexical bundles based on their typical uses and meanings, and second, to determine the extent to which each functional category is utilized in the academic contexts in an attempt to arrive at a better understanding of the issues in this type of discourse (Salazar, 2011). Table 6 presents the functional description of the top 30 most frequent four-word lexical bundles.

Furthermore, Table 7 presents the number and percentage of each functional category of the members in the finalized list. As shown in Table 7, text-oriented four-lexical bundles were the largest group of bundles in the FST Corpus.

Table 7

Number and Percentages of Functional Lexical Bundles of the FST Corpus

Functions	*Number*	*Percentage*	*Sub-Categories*	*Number*
Research-oriented	63	41.18	Location	4
			Procedure	36
			Quantification	22
			Description	1
			Topic	0
Text-oriented	86	56.20	Transition	9
			Resultative	29
			Structuring	27
			Framing	21
Participant-oriented	4	2.61	Engagement	2
			Stance features	2

One hundered and fifty-three lexical bundles were identified in a corpus of 4.7 million running words. Of these 153, the most frequent 4-word lexical bundle was the transition signal *on the other hand*, which occurred 859 times in all 38 journals. This is in line with Biber (2006), Hyland (2008b) and Allen (2009). This 4-word bundle is mostly typical in written academic texts rather in spoken genre (Allen, 2009). *Can be used as*, *in the production of* (procedure signals) and *results were expressed as* (structuring signal) were the least frequent lexical bundles which occurred in 37, 30, and 27 journals, respectively.

All lexical bundles were also analyzed for the functions they serve in FST Corpus. As Table 7 shows, text-oriented functions are used much more frequently than the other two functions. Of all the 153 lexical bundles on the list, 86 (56.20%) are text-oriented, while 63 (41.18%) are of the research-oriented type, and only 4 (2.61%) are participant-oriented.

As can be seen, text-oriented lexical bundles form approximately 60% of the FST Corpus. Text-oriented bundles, as Hyland (2008b) put it, reflect "the more discursive and evaluative patterns of argument" (p. 16). Hyland (2008b) claimed that text-oriented bundles could be characteristic of "soft science". However, the findings of the present study showed that such lexical bundles also play a key role in "hard science" as well.

These findings are consistent with those of Hyland (2008b) in which Applied Linguistics and Business studies relied on text-oriented functions. However, they are not in line with Hyland's (2008b) other disciplines, Biology and Electronic engineering, which greatly relied on research-oriented functions. Our findings are not in keeping with those of Allen (2009) either. Allen found research-oriented lexical bundles had the highest proportions in his corpus. Beng and Keong's (2015) findings also showed science-based texts employ more research-based lexical bundles, but art-based passages employ more participant-oriented functions.

Furthermore, the most frequently occurring subcategory under the text-oriented function was *resultative,* and the least frequently occurring subcategory was *transition*. Under the research-oriented function, procedure was the most frequently occurring lexical bundle, but description was the least frequently occurring lexical bundle. Finally, both stance and engagement under the participant-oriented function occurred equally frequently.

Hyland (2008b) defined text-oriented lexical bundles as "concerned with the organisation of the text and its meaning as a message or argument" (p.13) and further categorized such lexical bundles into four sub-categories: Transition signals (i.e. *in addition to the*), Resultative signals (i.e. *these results suggest that*), Structuring signals (i.e. *in the next section*), and Framing signals (i.e., *in the presence of*). Some text-oriented bundles found in the list of 153 most frequent 4-word lexical bundles are presented below.

- As can be inferred from the above data, the glycerol concentration had a negative effect on the E0 values and a positive influence on the E00 values. ***On the other hand,*** the chitosan percentage affects positively both E0 and E00 values. **(Transition)**
- The duration of subsequent shear treatment ***was found to be*** of no influence on the enhancement of the fibril formation. **(Resultative)**
- To observe the bacterial movements, an appropriate experimental arrangement was necessary, ***as shown in Fig***. 1, in order to protect NOC as well as A. **(Structuring)**
- The A_i was obtained by fitting the viscosity ***as a function of*** shear rate. **(Framing)**

Among text-oriented subcategories, *resultative* with 29 occurrences followed by *structuring* with 27 occurrences are the highest sub-categories and *transition* with 9 occurrences is the lowest. This means that 65.12% of the text-oriented lexical bundles in the corpus were used to frame arguments, make connections, and refer to limitations. The rest of the 86 bundles which accounts for 34.88% were utilized to establish additive links, compare and contrast, signal conclusions, mark cause and effect relations, cite sources, signal generally accepted, and to introduce aims.

Because all discourse and cohesive markers belong to text-oriented function of bundles (Hyland, 2012) and because these types of lexical bundles are the important parts of the texts, it can be concluded that FST authors mostly focus on the argument or the message they tend to communicate to the readers. In a way, this shows the disciplinary competence in the writers as they are experts in FST and they know and understand the audience. Through text-reflexive markers, authors direct readers' attention to their thoughts and ideas. FST researchers use text-oriented lexical bundles to make their writing as coherent as possible, make appropriate connections, and clarify and examine their ideas. Through text-oriented lexical bundles, the processes in the articles are easier for readers to understand and follow as they create logical arguments between and among the paragraphs and provide "well-placed textual signposts" (Salazar, 2011, p. 122).

As far as research-oriented lexical bundles are concerned, writers comparatively used fewer of this type (63, 41.18%). These types of lexical bundles are, in fact, related to the content of the research itself, and Hyland (2008b) defined them as the type that "helps writers to structure their activities and experiences of the real world" (p. 13). Such lexical bundles are divided into five sub-categories: Location (i.e. *in the present study*), Procedure (i.e. *the purpose of the*), Quantification (i.e. *a wide range of*), Description (i.e. *the surface of the*), Topics (i.e. *in the Hong Kong*). Some research-oriented bundles found in the list are presented below.

- As modified, the purification method ***used in this study*** proved particularly efficient for the bacteriocin in fraction D81, whose yield 46%. **(Procedure)**
- In addition, ***one of the most*** important sources of mold contamination of salted fish is the fish itself (Delcourt et al., 1994). **(Quantification)**
- It highlighted the concentrations of benzoic acid during all aging time, but especially ***at the end of*** aging, almost fifteen times higher than the highest detected concentration in wine aged with other

species, in accordance to detected levels in toasted woods. **(Location)**

- The negative control consisted of pretreatment of the monolayers with PBS but ***in the absence of*** subsequent reovirus inoculation. **(Description)**

Out of the 63 identified research-oriented lexical bundles, the *procedure* sub-category with 36 occurrences (57.14%) followed by *quantification* with 22 occurrences (34.90%) are the highest subcategories. Next is *location* function with four occurrences, followed by *description* with only one occurrence. In other words, 92.04% of the research-oriented lexical bundles in FST were used to describe events, methods and measures of any kind. The rest of the lexical bundles account for 7.96% of research-oriented function. These lexical bundles were utilized to describe time, place, quality, degree, categories, and order. "The scale of this use functions to impart a greater real world, laboratory-focused sense to writing in the hard sciences" (Hyland, 2008b, p.14). It can be argued that the authors mostly tend to describe the methods, research objects, contexts, equipment, events, actions, proportions, quantities, and changes in detail as most of the studies conducted in FST are concerned with experiments, evaluations, and results. This is, in fact, in line with Hyland (2008b) who commented that:

> The significantly greater use of research-oriented bundles in the hard knowledge fields also expresses something of a scientific ideology which emphasizes the empirical over the interpretive, minimizing the presence of researchers and contributing to the ''strong'' claims of the sciences. Highlighting research rather than its presentation places greater burden on research practices and the methods, procedures and equipment used, and this allows scientists to emphasize demonstrable generalizations rather than interpreting individuals. New knowledge, then, is accepted on the basis of empirical demonstration and experimental results designed to test hypotheses related to gaps in knowledge. (p. 15)

Participant-oriented lexical bundles, on the other hand, accounting for only 2.61% of the FST Corpus, had the lowest frequency amongst the three main functions. This finding is consistent with those of Allen (2009), Beng and Keong (2015), and Hyland (2008b). These lexical bundles focus on the reader, or the writer of the text which represent the "key aspects of interaction in texts" (Hyland, 2008b, p. 18). Participant-oriented functions are categorized into Stance features (i.e., are likely to be) and Engagement (i.e., it should be noted that). Stance bundles basically concern the ways writers employ to convey evaluations,

judgments, and degrees of commitment to what they say; engagement, on the other hand, "refers to the ways writers intervene to actively address readers as participants in the unfolding discourse" (Hyland, 2008b, p. 18). Some examples of these lexical bundles, the purpose of which in the texts is to direct readers' attention to certain understanding and interpretation, are presented below.

- ***It is important to*** note that, although compounds might be detected as peaks on a chromatogram, these compounds might not be odor-active, and that human thresholds for these odors could be above the detected concentrations in the milk matrix. **(Engagement)**
- The ability to quantify the water content from the same multispectral images is furthermore investigated, showing that ***it is possible to*** assess different quality parameters from the same multispectral image and thereby saving time compared to the process of obtaining the information through visual observations or laboratory work. **(Stance)**

Out of the four identified participant-oriented lexical bundles, two were identified as *engagement* and two as *stance*. Engagement lexical bundles are used to engage readers by using "a modal of obligation or a predicative adjective expressing the writer's judgment of necessity/importance" (Hyland, 2008b, p. 18) and by engaging the readers in the discourse at points critical to the writer, thereby leading them to give interpretations, but stance lexical bundles are mainly used to communicate caution or uncertainty; they are almost expressed impersonally to convey the FST writers' attitudes and evaluations. According to the findings of this study, FST writers tend to use discourse only to describe procedures, experiments, conditions, as well as sharing the findings with the reader. This is mostly because FST writers work with exact numbers and evaluations, and there is no room for any caution or error over the values determined by the standards and because interpretations are made and conclusions are drawn solely based on experiments, numbers and observations.

5. Conclusion and Implications

Disciplines tend to use certain lexical bundles serving functions which may vary from one study to another. For science-based disciplines, lexical bundles indicating procedure, quantity, and resultative signals seem to be predominant, as they did in this study to quantify concrete and abstract nouns since they rely heavily on figures and facts; to denote ways experiments are carried out; and to explain a process or an action. These findings seem to confirm that the functions of lexical bundles are specific to particular disciplines. The variations in frequencies and functions prove

that to express their thoughts and ideas, the writers of various fields of studies draw on different possible resources.

This study showed the significance of lexical bundles in FST. To begin with, teaching the most frequent lexical bundles helps graduate students of FST understand the views, ideas, processes, experiments, and descriptions much better. Learning lexical bundles based on their functions and in rich contexts is more productive as graduate students are familiarized with the use of the bundles and the meaning they convey.

Second, using lexical bundles while writing an academic text in a writing class could result in more native like performance. This improves graduate students' proficiency in both reading comprehension and writing, and more importantly, it boosts their confidence.

Third, lexical bundles "occur and behave in dissimilar ways in different disciplinary environments" (Hyland, 2008b, p. 20), and it is essential that EAP course designers understand that the most appropriate starting point for instruction is the student's specific target context. Therefore, students should deal with the lexical bundles in the academic texts related to their discipline. They should also see the lexical bundles in their academic texts, understand the meanings they convey, how they work, and why they are used. This way they can both recognize them in any text related to their discipline any time and use them while writing a text on a subject related to their field of study.

References

Adel, A., & Erman, B. (2012). Recurrent word combinations in academic writing by native and non-native speakers of English: A lexical bundles approach. *English for Specific Purposes, 31*(2), 81-92.

Allen, D. (2009). Lexical bundles in learner writing: An analysis of formulaic language in the ALESS Learner Corpus. *Komaba Journal of English Education, 1,* 25-36.

Alquraishi, M. (2014). *Lexical bundles in an advanced antics writing class and engineering texts: A functional analysis*. Unpublished Master's thesis. Colorado State University, Fort Collins, Colorado. Retrieved from fac.ksu.edu.sa/sites/default/files/alquraishi_mohammed_2nd.pdf.

Altenberg, B. (1998). On the phraseology of spoken English: The evidence of recurrent word-combinations. In A. P. Cowe. (Ed.), *Phraseology* (pp. 101-122). Oxford: Clarendon Press.

Anthony, L. (2004). AntConc: A learner and classroom friendly, multi-platform corpus analysis toolkit. *IWLeL: An Interactive Workshop on Language e-Learning*, 7-13. Retrieved from http://www.researchgate.net/profile/Laurence_Anthony/publication

/267631346_Proceedings_of_IWLeL_2004_An_Interactive_Workshop_on_Language_Elearning_2004/links/5458cd870cf26d5090acf212.pdf

Anthony, L. (2014). *AntConc (version 3.4.3) [computer software]*. Tokyo, Japan: Waseda University. Available from http://www.laurenceanthony.net/

Beng, C., & Keong, Y. (2014). Functional types of lexical bundles in reading texts of Malaysian University English Ttest: A Corpus study. *GEMA Online Journal of Language Studies*, *15*(1), 77-90.

Biber, D. (2006). *University language*: *A corpus-based study of spoken and written registers*. Amsterdam: Benjamin.

Biber, D. (2010). Corpus-based and corpus-driven analyses of language variation and use. In B. Heine, & H. Narrog (Eds.), *The Oxford handbook of linguistic analysis* (pp. 159–191). Oxford: Oxford University Press.

Biber, D., & Barbieri, F. (2007). Lexical bundles in university spoken and written registers. *English for Specific Purposes*, *26*(1), 263-286.

Biber, D., Conrad, S., & Cortes, V. (2003). Lexical bundles in speech and writing: An initial taxonomy. In A. Wilson, P. Rayson, & T. McEnery, (Eds.), *Corpus linguistics by the lune: A festschrift for Geoffrey Leech* (pp. 71-92). Frankfurt: Peter Lang.

Biber, D., Conrad, S., & Cortes, V. (2004). If you look at …: Lexical bundles in university teaching and textbooks. *Applied Linguistics, 25*(3), 371-405.

Biber, D., Johansson, S., Leech, G., Conrad, S., & Finegan, E. (1999). *Longman grammar of spoken and written English.* Harlow: Pearson.

Byrd, P., & Coxhead, A. (2010). On the other hand: Lexical bundles in academic writing and in the teaching of EAP. *University of Sydney Papers in TESOL, 5*, 31-64. Retrieved from http://faculty.edfac.usyd.edu.au/projects/usp_in_tesol/pastissues.htm

Chen, Y., & Baker, P. (2010). Lexical bundles in L1 and L2 academic writing. *Language learning & technology, 14*(2), 30-49.

Conrad, S., & Biber, D. (2004). The frequency and use of lexical bundles in conversation and academic prose. *Lexicographica: International Annual for Lexicography, 20,* 56-71.

Cortes, V. (2001). *Lexical bundles in context*: *A new taxonomy*. Unpublished Manuscript, Northern Arizona University, Arizona.

Cortes, V. (2002). *Lexical bundles in academic writing in history and biology*. (Unpublished Doctoral dissertation), Northern Arizona University, Arizon.

Cortes, V. (2004). Lexical bundles in published and student disciplinary writing: Examples from history and biology. *English for Specific Purposes*, *23*(4), 397-423.

Grabowski, L. (2015). Keywords and lexical bundles within English pharmaceutical discourse: A corpus-driven description. *English for Specific Purposes, 38*(2), 23-33

Hyland, K. (2008a). Academic clusters: Text patterning in published and postgraduate writing. *International Journal of Applied Linguistics, 18*(1), 41-62.

Hyland, K. (2008b). As can be seen: Lexical bundles and disciplinary variation. *English for Specific Purposes, 27*(1), 4-21.

Hyland, K. (2012). Bundles in academic discourse. *Annual review of applied linguistics*, 32, 150-169.

Karabacak, E., & Qin, J. (2012). Comparison of lexical bundles used by Turkish, Chinese, and American university students. *Procedia – Social and Behavioral Sciences,* 70, 622-628

McCarthy, M., & Carter, R. (2006). This that and the other: Multi-word clusters in spoken English as visible patterns of interaction. In M. McCarthy (Ed.), *Explorations in Corpus Linguistics* (pp. 7-26). New York: Cambridge University Press.

Salazar, D. (2011). *Lexical bundles in scientific English: A corpus-based study of native and non-native writing.* Unpublished PhD dissertation. University of Barcelona. Retrieved fromhttp://www.tdx.cat/bitstream/handle/10803/52083/DJLS_DISSERTATION.pdf.

Swales, J. M. (1990). *Genre analysis. English in academic and research setting.* Cambridge, England: Cambridge University Press.

Appendix (A)
The Most frequent FST 4-word Lexical Bundles

Number	*Lexical bundles*	*Range*	*Frequency*
1.	on the other hand	38	859
2.	in the present study	38	811
3.	in the presence of	37	695
4.	in the case of	38	605
5.	as a function of	33	491
6.	as shown in fig	34	479
7.	at the end of	38	463
8.	are shown in table	38	350
9.	used in this study	37	348
10.	as well as the	38	347
11.	was found to be	38	339
12.	as a result of	38	329
13.	on the basis of	38	317
14.	be due to the	37	302
15.	in the range of	37	293
16.	are shown in fig	34	282
17.	is shown in fig	33	278
18.	an increase in the	38	275
19.	in this study the	38	270
20.	the effect of the	38	251
21.	was added to the	38	249
22.	one of the most	38	241
23.	the results of the	37	239
24.	a flow rate of	36	236
25.	according to the method	37	222
26.	a wide range of	38	220
27.	in the absence of	35	204
28.	was used as a	38	204
29.	this study was to	37	199
30.	has been shown to	36	196
31.	the surface of the	35	196
32.	higher than that of	35	195
33.	it was found that	34	195

34.	were found to be	37	195
35.	may be due to	36	194
36.	to the presence of	37	193
37.	at a flow rate	35	192
38.	was used as the	37	191
39.	as shown in table	37	190
40.	it is important to	37	189
41.	be explained by the	35	187
42.	the shelf life of	26	186
43.	were carried out in	37	179
44.	with respect to the	34	179
45.	are presented in table	37	177
46.	an important role in	37	176
47.	used to determine the	38	175
48.	can be used to	37	174
49.	in agreement with the	38	174
50.	at room temperature for	37	172
51.	the temperature of the	29	171
52.	the fact that the	36	169
53.	was used for the	38	165
54.	by the addition of	34	164
55.	of the present study	36	164
56.	could be due to	34	160
57.	the concentration of the	34	159
58.	at a concentration of	29	158
59.	it has been reported	36	158
60.	was used to determine	37	158
61.	to the fact that	36	157
62.	was determined by the	36	157
63.	in accordance with the	37	156
64.	it can be seen	30	156
65.	at the same time	36	155
66.	for the production of	31	154
67.	on the surface of	37	151
68.	were obtained from the	35	147
69.	the presence of the	33	146
70.	in a water bath	31	145

71.	it is possible to	36	145
72.	has been reported that	32	142
73.	is shown in table	36	141
74.	according to the manufacturer	26	140
75.	is in agreement with	35	139
76.	similar to that of	35	139
77.	was carried out using	37	137
78.	as can be seen	28	135
79.	in this study we	31	135
80.	with the exception of	33	134
81.	incubated for hour at	24	133
82.	the difference between the	35	133
83.	were purchased from X	32	133
84.	a function of the	27	132
85.	is due to the	32	132
86.	was observed in the	34	132
87.	due to the presence	34	131
88.	it is possible that	33	131
89.	experiments were carried out	30	130
90.	to the method of	31	129
91.	a decrease in the	33	128
92.	have been shown to	33	128
93.	studies have shown that	30	127
94.	at the beginning of	36	126
95.	be related to the	36	126
96.	has been reported to	35	126
97.	in order to obtain	37	126
98.	the presence of a	37	126
99.	a result of the	35	125
100.	can be seen that	28	125
101.	for the determination of	28	124
102.	in addition to the	36	124
103.	the size of the	29	123
104.	probably due to the	36	122
105.	the present study was	37	122
106.	it was observed that	31	121
107.	in order to determine	35	120
108.	the composition of the	33	120

109.	it has been shown	34	119
110.	the basis of the	33	119
111.	was carried out by	35	119
112.	with the addition of	30	119
113.	there were no significant	32	118
114.	in the form of	35	117
115.	the beginning of the	34	116
116.	the moisture content of	25	116
117.	are given in table	32	115
118.	the effects of the	33	115
119.	in the present work	33	114
120.	the method described by	33	114
121.	as the amount of	27	113
122.	are in agreement with	35	112
123.	is based on the	35	112
124.	been shown to be	34	111
125.	at room temperature the	34	110
126.	can be seen in	29	110
127.	for each of the	24	110
128.	it should be noted	34	110
129.	the increase in the	32	110
130.	a final concentration of	28	109
131.	the case of the	35	109
132.	due to the fact	32	108
133.	are listed in table	35	107
134.	are summarized in table	34	107
135.	the increase of the	27	107
136.	the rest of the	32	107
137.	the bottom of the	26	106
138.	to the formation of	29	105
139.	did not affect the	32	104
140.	can be explained by	31	103
141.	could be explained by	29	103
142.	it is known that	37	103
143.	the manufacturer X instructions	24	103
144.	Procedure of this study	35	103
145.	might be due to	29	102

146.	play an important role	34	102
147.	to the manufacturer x	23	102
148.	were added to the	33	102
149.	at a rate of	26	101
150.	with an increase in	25	101
151.	can be used as	37	100
152.	in the production of	30	100
153.	results were expressed as	27	100

Appendix (B)

Functional Analysis of the Lexical Bundles

Number	*Lexical bundles*	*Sub-Category*	*Main function*
1.	on the other hand	Transition	Text-Oriented
2.	in the present study	Structuring	Text-Oriented
3.	in the presence of	Framing	Text-Oriented
4.	in the case of	Framing	Text-Oriented
5.	as a function of	Framing	Text-Oriented
6.	as shown in fig	Structuring	Text-Oriented
7.	at the end of	Location	Research-Oriented
8.	are shown in table	Structuring	Text-Oriented
9.	used in this study	Procedure	Research-Oriented
10.	as well as the	Transition	Text-Oriented
11.	was found to be	Resultative	Text-Oriented
12.	as a result of	Resultative	Text-Oriented
13.	on the basis of	Framing	Text-Oriented
14.	be due to the	Resultative	Text-Oriented
15.	in the range of	Quantification	Research-Oriented
16.	are shown in fig	Structuring	Text-Oriented
17.	is shown in fig	Structuring	Text-Oriented
18.	an increase in the	Quantification	Research-Oriented
19.	in this study the	Structuring	Text-Oriented
20.	the effect of the	Resultative	Text-Oriented
21.	was added to the	Procedure	Research-Oriented
22.	one of the most	Quantification	Research-Oriented
23.	the results of the	Resultative	Text-Oriented

24.	a flow rate of	Quantification	Research-Oriented
25.	according to the method	Procedure	Research-Oriented
26.	a wide range of	Quantification	Research-Oriented
27.	in the absence of	Description	Research-Oriented
28.	was used as a	Procedure	Research-Oriented
29.	this study was to	Structuring	Text-Oriented
30.	has been shown to	Structuring	Text-Oriented
31.	the surface of the	Location	Research-Oriented
32.	higher than that of	Quantification	Research-Oriented
33.	it was found that	Resultative	Text-Oriented
34.	were found to be	Resultative	Text-Oriented
35.	may be due to	Resultative	Text-Oriented
36.	to the presence of	Framing	Text-Oriented
37.	at a flow rate	Quantification	Research-Oriented
38.	was used as the	Procedure	Research-Oriented
39.	as shown in table	Structuring	Text-Oriented
40.	it is important to	Engagement	Participant-Oriented
41.	be explained by the	Resultative	Text-Oriented
42.	the shelf life of	Quantification	Research-Oriented
43.	were carried out in	Procedure	Research-Oriented
44.	with respect to the	Framing	Text-Oriented
45.	are presented in table	Structuring	Text-Oriented
46.	an important role in	Resultative	Text-Oriented
47.	used to determine the	Procedure	Research-Oriented
48.	can be used to	Procedure	Research-Oriented
49.	in agreement with the	Transition	Text-Oriented
50.	at room temperature for	Quantification	Research-Oriented
51.	the temperature of the	Quantification	Research-Oriented
52.	the fact that the	Framing	Text-Oriented
53.	was used for the	Procedure	Research-Oriented
54.	by the addition of	Procedure	Research-Oriented
55.	of the present study	Structuring	Text-Oriented
56.	could be due to	Resultative	Text-Oriented
57.	the concentration of the	Quantification	Research-Oriented
58.	at a concentration of	Quantification	Research-Oriented
59.	it has been reported	Structuring	Text-Oriented
60.	was used to determine	Procedure	Research-Oriented

61.	to the fact that	Framing	Text-Oriented
62.	was determined by the	Procedure	Research-Oriented
63.	in accordance with the	Framing	Text-Oriented
64.	it can be seen	Resultative	Text-Oriented
65.	at the same time	Framing	Text-Oriented
66.	for the production of	Procedure	Research-Oriented
67.	on the surface of	Location	Research-Oriented
68.	were obtained from the	Procedure	Research-Oriented
69.	the presence of the	Framing	Text-Oriented
70.	in a water bath	Location	Research-Oriented
71.	it is possible to	Stance	Participant-Oriented
72.	has been reported that	Structuring	Text-Oriented
73.	is shown in table	Structuring	Text-Oriented
74.	according to the manufacturer	Procedure	Research-Oriented
75.	is in agreement with	Transition	Text-Oriented
76.	similar to that of	Transition	Text-Oriented
77.	was carried out using	Procedure	Research-Oriented
78.	as can be seen	Resultative	Text-Oriented
79.	in this study we	Structuring	Text-Oriented
80.	with the exception of	Framing	Text-Oriented
81.	incubated for hour at	Procedure	Research-Oriented
82.	the difference between the	Transition	Text-Oriented
83.	were purchased from X	Procedure	Research-Oriented
84.	a function of the	Framing	Text-Oriented
85.	is due to the	Resultative	Text-Oriented
86.	was observed in the	Resultative	Text-Oriented
87.	due to the presence	Resultative	Text-Oriented
88.	it is possible that	Structuring	Text-Oriented
89.	experiments were carried out	Procedure	Research-Oriented
90.	to the method of	Procedure	Research-Oriented
91.	a decrease in the	Quantification	Research-Oriented
92.	have been shown to	Structuring	Text-Oriented
93.	studies have shown that	Structuring	Text-Oriented
94.	at the beginning of	Procedure	Research-Oriented
95.	be related to the	Resultative	Text-Oriented
96.	has been reported to	Structuring	Text-Oriented
97.	in order to obtain	Procedure	Text-Oriented

98.	the presence of a	Framing	Text-Oriented
99.	a result of the	Resultative	Text-Oriented
100.	can be seen that	Resultative	Text-Oriented
101.	for the determination of	Procedure	Research-Oriented
102.	in addition to the	Transition	Text-Oriented
103.	the size of the	Quantification	Research-Oriented
104.	probably due to the	Resultative	Text-Oriented
105.	the present study was	Structuring	Text-Oriented
106.	it was observed that	Resultative	Text-Oriented
107.	in order to determine	Procedure	Text-Oriented
108.	the composition of the	Procedure	Research-Oriented
109.	it has been shown	Structuring	Text-Oriented
110.	the basis of the	Framing	Text-Oriented
111.	was carried out by	Procedure	Research-Oriented
112.	with the addition of	Procedure	Research-Oriented
113.	there were no significant	Transition	Text-Oriented
114.	in the form of	Framing	Text-Oriented
115.	the beginning of the	Procedure	Research-Oriented
116.	the moisture content of	Quantification	Research-Oriented
117.	are given in table	Structuring	Text-Oriented
118.	the effects of the	Resultative	Text-Oriented
119.	in the present work	Structuring	Text-Oriented
120.	the method described by	Procedure	Research-Oriented
121.	as the amount of	Quantification	Research-Oriented
122.	are in agreement with	Transition	Text-Oriented
123.	is based on the	Framing	Text-Oriented
124.	been shown to be	Structuring	Text-Oriented
125.	at room temperature the	Quantification	Research-Oriented
126.	can be seen in	Resultative	Text-Oriented
127.	for each of the	Framing	Text-Oriented
128.	it should be noted	Engagement	Participant-Oriented
129.	the increase in the	Quantification	Research-Oriented
130.	a final concentration of	Quantification	Research-Oriented
131.	the case of the	Framing	Text-Oriented
132.	due to the fact	Resultative	Text-Oriented
133.	are listed in table	Structuring	Text-Oriented
134.	are summarized in table	Structuring	Text-Oriented

135.	the increase of the	Quantification	Research-Oriented
136.	the rest of the	Framing	Text-Oriented
137.	the bottom of the	Framing	Text-Oriented
138.	to the formation of	Procedure	Research-Oriented
139.	did not affect the	Resultative	Text-Oriented
140.	can be explained by	Resultative	Text-Oriented
141.	could be explained by	Resultative	Text-Oriented
142.	it is known that	Stance	Text-Oriented
143.	the manufacturer X instructions	Procedure	Research-Oriented
144.	Procedure of this study	Procedure	Text-Oriented
145.	might be due to	Resultative	Text-Oriented
146.	play an important role	Resultative	Text-Oriented
147.	to the manufacturer x	Procedure	Research-Oriented
148.	were added to the	Procedure	Research-Oriented
149.	at a rate of	Quantification	Research-Oriented
150.	with an increase in	Quantification	Research-Oriented
151.	can be used as	Procedure	Research-Oriented
152.	in the production of	Procedure	Research-Oriented
153.	results were expressed as	Structuring	Text-Oriented